

## ON THE TREMATODES OF AUSTRALIAN BIRDS.

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With Plates IX to XIX.

*[Read before the Royal Society of N. S. Wales, December 6, 1916.]***Introduction.**

THE subject-matter of this paper naturally falls into two parts. In the first part twenty-one species, belonging to nine families or sub-families of Trematodes, are described as new. Up to this time thirty-three species were already known from birds as hosts, and in the second part of this paper the relationships of all fifty-four are discussed and some attempt made to show the meaning of their relationships and distribution.

For many of the specimens which form the subject-matter of Part I, I am indebted to four of my friends, Dr. T. Harvey Johnston, of the University of Queensland, Dr. S. J. Moreau of the Queen Victoria Sanatorium, Wentworth Falls, Dr. J. B. Cleland of the Government Bureau of Microbiology, Sydney, and Mr. Launcelot Harrison, lately demonstrator of Zoology in the Sydney University. Where possible, that is, in the case of those collected by myself, the worms have been studied in the living condition; and in all cases by means of whole mounts and serial sections, except in two, where there was only a single specimen. The whole mounts have been in most cases stained with hæmatoxylin which I have found, on the whole, the most suitable stain for these worms; and the serial sections with hæmatoxylin (either iron or Ehrlichs) and eosin.

In describing each new species a short diagnosis has been given in every case, summarising the principal features of the species; those which are regarded by me as being

pecially characteristic are printed in italics. In addition to this diagnosis a sufficiently detailed account of its anatomy has been given, and its relationships to other forms discussed.

## PART I.

### Family FASCIOLIDÆ.

#### Subfamily CENOGONIMINÆ.

SCAPHANOCEPHALUS AUSTRALIS, sp. n. (Fig. 1 and 1a.)

*Diagnosis*.—Body like *S. expansus* in shape, but *shorter and broader*, yet with larger suckers and pharynx. Integument with a few small spines. Testes not deeply lobed, but *fairly solid bodies*, with their surfaces marked into low ridges by shallow grooves. Eggs larger, but especially broader than in *S. expansus*, from  $0.024 \times 0.019$  mm., to  $0.032 \times 0.0213$  mm.

*Host*.—*Haliaetus leucogaster*, in the small intestine.

Type specimen in the Australian Museum, Sydney, No. W. 426.

In June 1910, at Terrigal, a coastal village fifty miles north of Sydney, I collected three specimens of a trematode from the small intestine of a white-bellied sea-eagle, *Haliaetus leucogaster*, which appeared at once to be very closely related to, if not identical with *Scaphanocephalus expansus*, Crepl., described by Jägerskiöld<sup>(19)</sup> and obtained from the stomach of a sea-eagle near Tor, on the Red Sea. A more exhaustive examination with the microscope revealed a number of characteristic differences in the Australian form, which I now describe as a new species under the name of *S. australis*. My specimens, after an examination with a simple lens in a living state, were shaken up in salt solution, fixed in sublimate acetic and transferred to 70% alcohol. One specimen was mounted whole, and the other two cut into sections. Both in the

living state and after preservation, the body in all cases was bent in the form of a narrow V, the anterior half bending down sharply, in a ventral direction on to the posterior half. When this was pushed back, the worm showed the very characteristic T shape, with the thin, expanded anterior end, produced outwards into a pair of lateral wings. The worms were quite flat, *i.e.*, their dorso-ventral thickness was quite small in comparison with their width. The Australian form proved to be shorter and broader than the African. The length varied from 3 to 3.25 mm., the breadth of the anterior part being 2.2 mm., that of the posterior part 1.17 mm. The cuticle is smooth, but sections showed the presence of small spines lying in the cuticle, hardly projecting on the surface: the striping of the anterior end mentioned by Jägerskiöld, and produced by the presence of numerous longitudinal grooves on the surface, was hardly noticeable. The suckers are small, but larger than those of its congener, though the latter worm is larger. The oral sucker is  $0.134 \times 0.107$  mm.; the pharynx is  $0.096 \times 0.075$  mm., the combined ventral and genital sucker  $0.276 \times 0.214$  mm.

The excretory pore is situated on the dorsal aspect of the body 0.07–0.13 mm., from the posterior end.

*Alimentary Canal.*—The pharynx is fairly well developed, the oesophagus narrow and moderately long (0.27 mm.), the intestinal limbs reaching almost to the posterior end of the body, and following the contour of the lateral borders, so that in the anterior part of the body they form wide bays extending into the lateral wings of the worm. The intestinal limbs, while being comparatively narrow, (0.05 mm.) in diameter, are much wider than in *S. expansus*, where they measure only 0.012 mm.

*Excretory System.*—The excretory vesicle, while conforming, in general, pretty closely to the form described

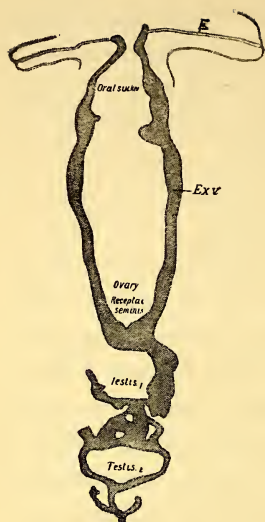


Fig. 1.—Excretory system of *Scaphanocephalus australis*. *Ex. v.* excretory vesicle; *E.* collecting vessels. Projection on squared paper from a series of transverse sections. The names of the organs that form easily recognisable features are written down in the position in which the organ occurs.

ends, while in another it is the left.

The remaining branch, behind the ovary and receptaculum seminis, divides into two long arms which run forwards, widely separated from one another by the loops of the uterus, but converging in front of this so as to come almost into contact in front of the ventral sucker, where they end as more or less wide pockets. Each of these pockets gives off a tube that runs out fairly straight at right angles to the long axis of the body, into the lateral wings: these transverse tubes are excretory vessels, as distinct from the vesicle, their walls being of a character entirely different from those of the latter. They pass to the outer side of

by Jägerskiöld in *S. expansus* shows some differences. Text figure 1 is a projection on squared paper, made from a series of transverse sections of the ventral aspect of the excretory vesicle and the two chief vessels. This vesicle differs from that of the African form chiefly in the fact that the main stem, just behind the posterior testis, divides into two branches which unite again in front of it, instead of the right branch ending blindly. Then in the space between the two testes these two wide branches form a network from which, at the level of the posterior end of the anterior testis two wide branches emerge, one passing round either side of the testis. One of these branches ends blindly and the exact arrangement seems to be subject to variation, for in one of my specimens it is the right which so



the intestinal limbs and divide each into two branches, one of which runs forwards and inwards, the other backwards and inwards (fig. 1).

In addition to these vessels, a number of minute vessels arise from the vesicle at various points, and end in flame cells. The flame cell (fig. 1a) has a rounded body with a large nucleus and an elongated tuft of cilia.

*Nervous System.*—The cerebral ganglia lie just behind the pharynx, one on either side of the œsophagus. Large nerve trunks pass off from them backwards and outwards to the lateral border of the wings (fig. 1).

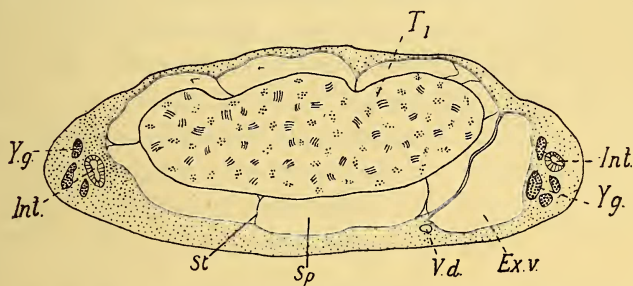


Fig. 2.—Transverse section through the region of one of the testes, showing the space by which the testis is surrounded, and the strands of connective tissue by which it is held in place. *Ex. v.*, excretory vesicle; *Int.*, intestine; *Sp.*, spaces round the testis; *St.*, strands crossing the space; *V.d.*, vas deferens; *Y.g.*, yolk-glands.

*Genitalia.*—The genital opening lies in the depth of the genital sinus, which is situated just in front of the junction of the wide anterior and the narrow posterior parts of the body. The ventral sucker, bounding the genital sinus in front is placed 0.543 mm., behind the oral sucker. The gonads lie in a straight line, one behind the other in the posterior half of the body, the ovary in front and the testes behind. The testes are large, oval, fairly solid bodies, (fig. 1), the surfaces raised up into a few wide, low ridges, but not deeply divided into lobes as in *S. expansus*. They are approximately equal in size and lie with their long

axes at right angles to the long axis of the body, and are surrounded by a very loose connective tissue or a cavity crossed by strands of connective tissue (Text fig. 2). The two vasa deferentia unite at a level some distance in front

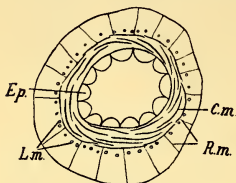


Fig. 3.—Transverse section through the vagina of *Scaphanocephalus australis*, showing the muscular layers in its walls. *Ep.*, lining epithelium; *C.m.*, circular muscle; *R.m.*, radial muscle; *L.m.*, longitudinal muscle.

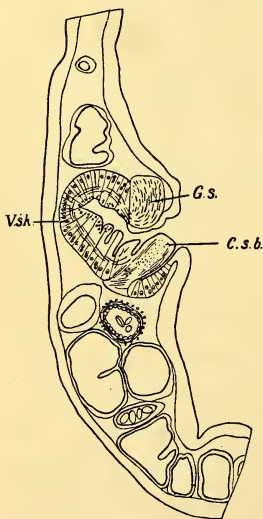


Fig. 4.—Longitudinal section of *Scaphanocephalus australis*, passing through the genital sucker. *C.s.b.*, cone-shaped body; *G.s.*, genital sucker; *V.sk.*, ventral sucker.

of the ovary after running for a space closely applied to one another, to enter together a more or less capacious vesicula seminalis; in some specimens it is very much larger than in others. There is no cirrus sac nor cirrus, but a fairly long ejaculatory duct with a group of prostate cells round its proximal end, lying free in the body parenchyma. This duct opens, close alongside the female opening, into a tubular common chamber 0.107 mm. long by 0.05 mm. wide. The walls of the vagina or metraterm are muscular and similar in structure to those of the ejaculatory duct. Surrounding the epithelial lining is a strong layer containing radial fibres, and in addition, longitudinal fibres closely applied to the layer of circular (text fig. 3).

The form of the "cone shaped" body of Jägerskiöld, and the arrangement of the muscular layers round the combined genital sinus and ventral sucker correspond closely with what is described for *S. expansus*.<sup>(19, pp. 6-10)</sup> The part of this complex sucker that represents

the "genital sucker" is in the form of a thick horseshoe-shaped band or semi-circular arch of muscle fibres, with the bow of the arch directed forwards. At the posterior end the two limbs give off a number of fibres that run into the circular layer of the ventral sucker. (Text fig. 4). Apparently this does not occur in *S. expansus* or it has been overlooked by Jägerskiöld.

The function of the "cone-shaped" body may be, as Jägerskiöld suggests, to "button" two copulating individuals together; and this may happen in such a way that the openings of the genital sinus in the two individuals are closely applied together so that the genital sinus of the one acting female at the time becomes filled with sperms from the one acting male. The peristaltic movements of the "vagina," movements which the structure of its muscular walls with its well marked circular and radial fibres shows it well able to perform, would then cause these sperms to pass into the female duct.

But the formation of these parts suggests another possible explanation to me. The absence of a proper cirrus or penis suggests that the animal is, perhaps, like so many other Trematodes that possess this character, self-fertilized. The "cone-shaped" body is of such a form and size, and so placed, that it would fit pretty accurately into the concavity of that specially well developed semicircular band of muscle fibres at the anterior border of the sinus, thus forming a closed cavity of that spacious depression formed by the combined sinus and ventral sucker (text fig. 5). Into this closed cavity the sperms could be ejected by the ejaculatory duct, to be taken up in turn by the movements of the vagina. The ovary is fairly large ( $0.407 \times 0.155$  mm.) placed with its long axis transverse, just behind the middle of the body. It is divided up into a considerable number of lobes. The ootype, yolk reservoir and transverse yolk

ducts lie behind the ovary. A receptaculum seminis, of considerable size, pear-shaped or rather like a cornucopia, lies on the right side, while at the same level but to the left is a fairly large "shell-gland."

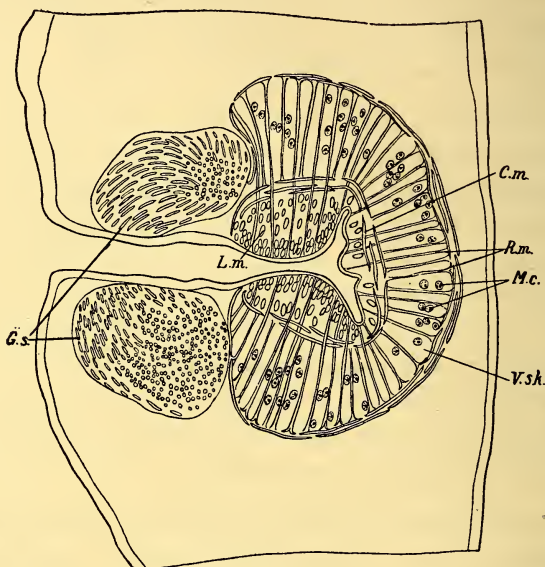


Fig. 5 —Transverse section *Scaphanocephalus australis*, in region of the ventral sucker, to show the arrangement of the muscle fibres in the genital and ventral suckers. *C.m.*, circular muscle; *G.s.*, genital sucker; *L.m.*, longitudinal muscle; *M.c.*, muscle cells; *R.m.*, radial muscle; *V.sk.*, ventral sucker.

There is a short straight Laurer's canal in the middle. The uterus, filled with numerous eggs, proceeds forwards to the genital opening in a series of five or six loops, transversely placed, and occupying the middle half of the body's width, not extending outwards beyond the intestinal limbs. The follicles of the yolk glands are small (0.027 mm.) and exceedingly numerous; in front not extending further forwards than the widely diverging parts of the intestinal limbs and reaching back, along the lateral aspects of the body to the extreme posterior end. Between and behind



the testes they extend inwards towards the middle line. This disposition corresponds pretty closely with what occurs in *S. expansus*.

The eggs are a broad oval, the average size of all those measured (a large number) being  $0.029 \times 0.02$  mm. The smallest egg measured was  $0.024 \times 0.019$  mm., the largest  $0.032 \times 0.022$  mm. They are thus distinctly larger, and especially broader than those of *S. expansus*, which measure  $0.027 \times 0.016$  mm.

The chief differences between *S. expansus* and *S. australis* are that the latter is shorter and broader, but at the same time has somewhat larger suckers and pharynx; the testes are very deeply lobed in *S. expansus*, but solid bodies with their surfaces marked rather into low ridges by shallow grooves in *S. australis*; and the eggs are larger, especially broader, in the latter.

Subfamily ECHINOSTOMINÆ.

HIMASTHLA HARRISONI, sp. n. (Fig. 10.)

*Diagnosis*.—Elongated, attenuated worm, flattened dorso-ventrally. Integument closely beset with thick spines. Head-collar with *twenty-four* spines in a single row on its border. Ratio of oral to ventral sucker 1 : 4. Testes and ovary close together in the posterior fifth of the body length. Yolk-glands confined to the posterior half of the body. Eggs broad elliptical, but pointed at both ends,  $0.091 \times 0.069$  —  $0.096 \times 0.074$  mm.

*Host*.—*Numenius cyanopus*, in the intestine.

Type specimen in the Australian Museum, Sydney, No. W, 427.

Three specimens of this worm were obtained from the Curlew, *Numenius cyanopus*, at Masthead Island, off the Queensland Coast, and one at Gladstone Q., by Launcelot Harrison, demonstrator of Zoology in Sydney University.

As is usual in this genus the body is very elongated and flattened. The anterior part of the body is very thin and delicate, and in the region of the ventral sucker is deeply concave. All the specimens are about 12 mm. long, and find their greatest breadth at the level of the gonads where they are 0.809 mm. wide. Just behind the cirrus sac the body is only 0.326 mm. wide, and gradually increases down to the level of the gonads. At the middle of the body the width is 0.632 mm. Behind the testes the body narrows to a blunt, rounded point. Down to the hinder end of the cirrus sac the integument is armed only with fine spines, but behind that level the body is covered with transverse rows of closely placed, thick spines which give it a transversely striped appearance. The spines stand very close together, without measurable interval and have the form of almost cubical blocks with the free end produced into a backwardly directed point. They gradually increase in size up to the level of the ovary and behind this point gradually fade away. At the middle of the body they are 0.021 mm. thick by 0.018 mm. high, while at the level of the ovary they are .027 mm. thick.

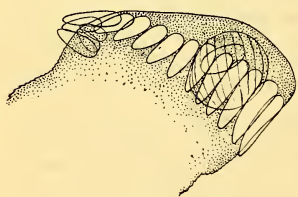


Fig. 6.—Head collar and spines of *Himasthla harrisoni*.

The head-collar is comparatively poorly developed but bears a row of conspicuous spines round its border. There are twenty-four of these spines, the largest along the lateral border measuring  $0.069 \times 0.015$  mm. On the ventral side of the collar the largest is  $0.057 \times 0.015$  mm. In addition to the spines round the border the ventral angles bear each four spines arranged in two pairs: two large and two small.

The oral sucker is very small; it is spherical in shape and has a diameter of 0.085 mm. The ventral sucker lies about

1 mm. behind the anterior end and projects prominently on the surface. It is fairly globular and has a diameter of 0.347 mm.

The ratio of the oral to the ventral sucker is 1:4. The oesophagus leading back from the small pharynx ( $0.116 \times 0.106$  mm.) bifurcates just in front of the anterior end of the cirrus sac, and the two intestinal limbs run back to the posterior end of the body.

The tubular excretory vesicle divides into two main branches immediately behind the posterior testis.

The genital pore lies in the middle line of the ventral surface just in front of the anterior border of the ventral sucker. The cirrus sac, which is nearly filled by the voluminous vesicula seminalis projects far behind the ventral sucker towards the posterior end.

The gonads are situated very far back and lie in the posterior body-fifth. The testes are large, somewhat irregular, elliptical bodies lying close together and one behind the other in the middle line. In one specimen the posterior  $0.776 \times 0.33$  mm., was a little longer than the anterior  $0.698 \times 0.31$  mm., but in two others they were equal in size and measured  $1.028 \times 0.388$  mm. The ovary is oval,  $0.252 \times 0.194$  mm., with the long axis transversely placed. It lies in the middle line a short distance in front of the testes. A very large shell-gland, which is traversed by the transverse yolk-ducts, occupies the space between the ovary and testis. The yolk-glands, which consist of large oval follicles,  $0.063 - 0.074$  mm. long by  $0.043$  mm. wide, occupy two lateral fields stretching from the middle of the body to the posterior end. These fields are interrupted at three places, at the level of the ovary and each of the testes, the intervals being bridged over by the longitudinal yolk-ducts only.

The uterus is extremely long and is thrown into numerous transverse coils. It contains numerous eggs. The eggs

are broad, elliptical and pointed at the ends, and vary a good deal in size, the smallest measuring  $0\cdot091 \times 0\cdot069$  mm., and the largest  $0\cdot096 \times 0\cdot074$  mm.

This species is obviously closely related to *H. rhigedana* Dietz,<sup>(13)</sup> parasitic in the intestine of *Numenius arabicus* and *N. arquatus*, of the Sinai peninsula. Among the differences one finds in these two forms is the number of spines on the border of the head-collar, twenty-four in the one and thirty in the other. While the ratio of the diameter of the oral to the ventral sucker is 1 : 4 in the Australian species, it is 1 : 3 in the Asian. The size of the spines on the posterior part of the body seems to be considerably larger in the Australian form, and the gonads much closer together.

ACANTHOPARYPHIUM SPINULOSUM, sp. n. (Fig. 7.)

*Diagnosis*.—Small form, 5·55 mm. long by 0·8 mm. broad. Integument of the anterior part of the body spiny. Head-collar *only half as broad* as the body. Collar spines twenty-three in number. Ratio of oral to ventral sucker 2 : 7. Ventral sucker situated *entirely in the first quarter* of the body length. Cirrus sac elongated, reaching back far beyond the posterior end of the ventral sucker. Cirrus spiny.

*Host*.—*Charadrius dominicus*, in the duodenum.

Type specimen in the Australian Museum, Sydney, No. W. 428.

Two individuals and a number of fragments of this species were obtained from the duodenum of a Golden Plover, *Charadrius dominicus*, at Cronulla, near Sydney, by Dr. Harvey Johnston and Dr. J. B. Cleland. It is a small worm 5·55 mm. long by 0·8 mm. broad in the region of the ventral sucker. There is little diminution in the width as far back as the posterior testis, but from this point to the posterior



end the worm gradually tapers to a blunt point. There is a narrow neck just behind the head-collar. The latter, 0·407 mm. broad, is only half as wide as the body. The collar-spines are arranged in an uninterrupted, single row, those along the lateral borders being the largest. There are twenty-three of these spines, and special groups on the ventral angles are wanting. The spines on the lateral border measure  $0\cdot075 \times 0\cdot016$  mm.

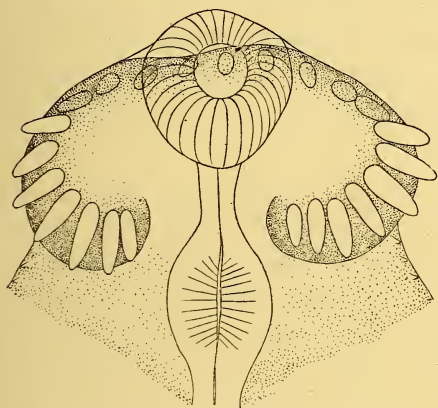


Fig. 7. Head collar and spines of *Acanthoparyphium spinulosum*.

The integument is closely beset with sharp-pointed spines as far back as the ventral sucker, where they begin to diminish in numbers and quite disappear at a point a little behind the sucker.

The oral sucker is nearly spherical,  $0\cdot155 \times 0\cdot145$  mm., the ventral sucker is also approximately spherical and measures  $0\cdot582 \times 0\cdot543$ , so that the ratio of the former to the latter is about 2 : 7.

There is a short prepharynx followed by a pharynx 0·133 mm. long by 0·107 mm., transverse diameter. The œsophagus is 0·388 mm. long, and the bifurcation of the intestine is situated just in front of the genital pore, and close to the anterior border of the ventral sucker.

The genital pore lies in the middle line close to the anterior border of the ventral sucker. The testes are placed one behind the other in the middle line in the middle of the body, and in one specimen are approximately spherical ( $0\cdot582 \times 0\cdot542$  mm.), in the other elliptical ( $0\cdot776$

$\times 0.542$  mm.). The ovary is oval in form, obliquely placed on one side of the middle line, and measures  $0.194 \times 0.136$  mm. It lies only a short distance in front of the testes, the space between being filled by the large gland of Mehlis. The cirrus sac is very elongated and reaches back to the level of the ovary. For the whole length of the ventral sucker it is tubular in form, but behind that point it swells out into a more or less pear-shaped structure, and in this part the coiled vesicula seminalis is contained. The long cirrus is lined by chitinous tubercles or blunt spines (text fig. 8). A number of prostate cells lie in the parenchyma of the cirrus sac in the posterior part of the division lined by the spines, and further back.

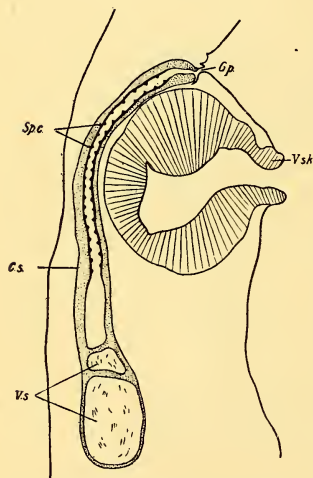


Fig. 8.—Figure combined from several longitudinal sections of *A. spinulosum* showing cirrus etc. C.s., cirrus sac; G.p., genital pore; Sp.c., spines on the cirrus (which is represented inverted in its position of rest); V.s., vesicula seminalis; V.sk., ventral sucker.

The yolk-gland field begins anteriorly at the level of the ovary some distance behind the ventral sucker, and is confined to the lateral parts of the body down to the posterior end of the testes. From this level the yolk-glands spread inwards to the middle, but stop short some little distance from the posterior end. The follicles are fairly large and round, varying in size from  $0.068$  to  $0.106$  mm., in diameter. The uterus is short and contains comparatively only a few oval eggs  $0.085 \times 0.069$  mm.

This species differs from *A. phœnicopteri*, Lühe, parasitic in a Flamingo *Phœnicopterus roseus*, at Tunis, the only other member of the genus, in a number of easily recognisable characters. In the first place

it is larger, being more than twice as long and twice as broad. The relative size of the head-collar is very different, for while it is as wide as the body in its widest part in *A. phœnicopteri* it is only half as wide in the Australian form.

In regard to the suckers, again, while the diameter of the ventral sucker in the latter is three and a half times as great as that of the oral sucker, in the former it is only twice as great, and is situated much farther back in the body. Though Dietz, in his account of the African species <sup>(13, pp. 365-8)</sup> makes no mention of the spines on the cirrus, I have no doubt that they will be found to be present if they are looked for in a series of longitudinal sections.

ECHINOPARYPHIUM OXYURUM, sp. n. (Fig. 6.)

*Diagnosis*.—Small worms, 5·8 mm., long with a well developed head-collar, and a *very distinct sharp-pointed tail*. Collar spines long. Integument armed with transverse rows of *rounded scales*. Ratio of oral to ventral sucker 1 : 4. Testes in the middle of the body. Eggs 0·096 — 0·107 mm. long by 0·054 — 0·08 mm. broad.

*Host*.—*Herodias timoriensis*, in the intestine.

Type specimen in the Australian Museum, Sydney, No. W. 429.

Four individuals of this species were sent me by Dr. Harvey Johnston, who obtained them from the intestine of an Egret, *Herodias timoriensis*, shot on the Burnett River in Queensland. They are all about the same length, 5·8 mm., and attain a maximum width at the ventral sucker of 0·698 mm. From the region of the testes the sides of the body, which is fairly flat, run parallel to a level near the posterior end when they converge in such a way as to form a distinct, sharp-pointed tail, which seems to be a very characteristic feature. The intestinal limbs and the yolk-

glands do not extend into this tail. The posterior half of the body is 0.425 mm. wide.

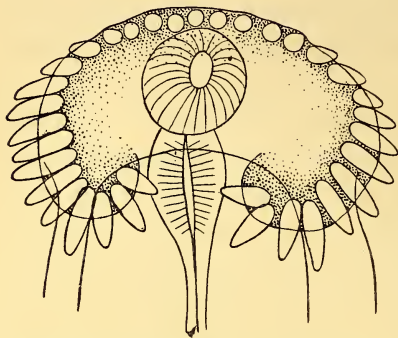


Fig. 9.—Head collar and spines of *Echinoparyphium oxyurum*

The head-collar is well developed, and nearly as wide (0.543) as the body in its widest part. It has the usual reniform shape and bears along its edge a single uninterrupted row of thirty-four spines. In his diagnosis of the genus Dietz says<sup>(13, p. 379)</sup> “Kopfkragen nierenförmig mit doppelter, dorsal nicht unterbrochener stachelreihe bewaffnet.” But I do not consider this feature of sufficient importance to make a generic distinction. Indeed, in a second species of this genus, which I describe below, the collar spines might be considered to be in a double row (see fig. 9, pl. XII), but they are so nearly in a single row that the difference in position might easily be overlooked. In *E. oxyurum*, however, they cannot be detected to lie in two rows. In addition to the row round the edge this species bears a group of four spines on each ventral lobe set at a different angle to the others, so that there are forty-two collar-spines altogether. The longest spines are 0.091 mm. long.

The integument in the region between the head-collar and the ventral sucker is armed with closely set scales or scale-like spines. These scales have a rounded free edge, and the part projecting on the surface is rather broader than long. The region of the body between the head-collar and the ventral sucker is concave through the bending down of the lateral edges of the body.



The oral sucker is small and globular, 0.15 mm. in diameter. The ventral sucker, which is rather more than its own length behind the oral, is 0.62 mm. long by 0.52 mm. broad, so that the ratio of the oral to the ventral sucker is 1 : 4. The pharynx is  $0.194 \times 0.097$  mm. and the oesophagus 0.388 mm. long. The intestinal fork lies just in front of the ventral sucker. The intestinal limbs end 0.388 mm. from the posterior extremity.

The genital pore lies a little behind the intestinal fork on the ventral surface, in the area dorsal to the anterior part of the ventral sucker. The cirrus sac is pear-shaped and extends back as far as the middle of the ventral sucker. The testes, elliptical in shape, are equal in size, and measure  $0.582 \times 0.252$  mm. They lie very close together, one behind the other in the middle line. They lie approximately in the middle of the body. The ovary is nearly globular in shape  $0.16 \times 0.19$  mm., and lies on the right side of the middle line, a short distance in front of the testes, with the gland of Mehlis directly behind it.

The yolk-glands consist of rather large, oval follicles 0.037 – 0.043 mm. long by 0.032 mm. broad. In front they do not extend as far forward as the ventral sucker, and behind the testes completely surround the intestinal limbs on each side, leaving for the most part a clear space in the middle. In the region of the testes and in front of this they are entirely confined to the lateral fields between the intestinal limbs and the sides of the body.

The uterus is short and contains in each specimen only a few large eggs. The eggs are rather variable in size, and in those of three specimens measured 0.096 – 0.107 mm. long by 0.058 – 0.064 mm. broad, but in the fourth specimen they were considerably broader and measured 0.107 mm. long by 0.08 mm. broad.

This species differs from *Echinoparyphium agnatum*, Dietz, in being much larger, in its much more markedly

developed collar, in its much larger collar spines (they are more than twice as long), and in its specially characteristic tail; while its integument is armed with broad scales, that of *E. agnatum* possesses fine spines.

Again, the ratio of the diameter of the oral to that of the ventral sucker in the latter is 1 : 5, but in the Australian form it is 1 : 4. Moreover the testes in the European form are much nearer the posterior end of the worm than in the Australian form.

It differs from *E. aconiatum*, Dietz, in being very much larger (four times as great); in the number of collar spines, forty-two as against thirty-seven; and in having the scales with which the integument is armed much less closely set. In *E. aconiatum* the ratio of the diameter of the oral to the ventral sucker is 1 : 3.

Further it differs from *E. elegans* Looss, not only in being much larger and different in shape, but also in the relationship of the suckers, as in Looss' species the ventral sucker is twice as great in diameter as the oral, while in the Australian form it is four times as great. The testes are situated much nearer the posterior end in *E. elegans* Looss.

*ECHINOPARYPHIUM HARVEYANUM*, sp. n. (Figs. 8 and 9).

*Diagnosis*.—A small worm with well developed head-collar, bearing twenty-nine collar-spines, including six on the ventral angles of the collar. Integument armed with sharp spines. Ventral sucker very prominent. Ratio of ventral to oral sucker 6 : 1. Cirrus sac reaching the middle of the ventral sucker. Testes in the middle of the body. Follicles of the yolk-glands very numerous and confined to the lateral fields of the body. Eggs 0·099 – 0·117 mm. long by 0·063 mm. broad.

*Host*.—*Micræca fascians*, in the gizzard.

Type specimen in the Australian Museum, Sydney, No. W. 430.

A single specimen of this worm was obtained by Dr. Harvey Johnston from the gizzard of *Microeca fascians* at the Burnett River. It is a small worm 5.75 mm. long by 0.523 mm. broad. The body was twisted through a right angle just behind the ventral sucker, so that in figure 8, while the anterior end is viewed from the side, the posterior part is viewed from the ventral surface.

The head-collar is well developed and is armed by twenty-three collar-spines arranged in a double row, but the two rows are set very nearly together so that without very close inspection they appear to be arranged in one row. These spines measure  $0.069 \times 0.021$  mm. In addition, there is a group of three large spines on each ventral angle of the collar, set in a direction very nearly at right angles to those of the edge of the collar. For the greater part of its length the body exhibits a fairly even breadth, but gradually becomes narrowed to a blunt point at the posterior end. The integument in the anterior part of the body is armed with sharp spines. These spines are very numerous in front of the ventral sucker: from this on to the region of the testes they become more scattered and further back vanish completely. The ventral part of the body in front of the ventral sucker is deeply concave, and into this hollow the ventral sucker projects very prominently (fig. 9).

The ventral sucker is 0.62 mm. long, and lies nearer the anterior end than in the other species of *Echinoparyphium*. The oral sucker is spherical and 0.106 mm. in diameter: so that the ratio of the oral to the ventral sucker is 1:6. The fork of the intestine lies just anterior to the ventral sucker and immediately behind it lies the genital pore. The comparatively large cirrus sac extends nearly to the middle of the sucker.

The testes are elliptical and smooth-edged,  $0.485 \times 0.194$  mm. in size. They lie close in the middle line, one closely behind the other. The small almost spherical ovary,  $0.136 \times 0.126$  mm., lies in front on the left side.

The yolk-glands, which run from a point some distance behind the ventral sucker to the posterior end, are confined to the lateral fields of the body, and do not anywhere pass beyond the intestinal limbs towards the middle line. The follicles are rounded  $0.027 - 0.037$  mm. in diameter. The uterus is short and little coiled, and the eggs few, large and variable in length,  $0.099 - 0.117$  long by  $0.063$  broad.

*E. harveyanum* differs from all the other species of *Echinoparyphium* in the small number of its collar-spines and in the close approximation of its ventral sucker to the anterior end. It differs from *E. aconiatum* and *E. oxyurum* in having the integument armed with sharp-pointed spines instead of rounded scales. The ratio of the oral sucker to the ventral is 1 : 6. The relationship in size of the oral and ventral suckers shows a very interesting gradation in the species of this genus. In *E. elegans*, Lss. it is 1 : 2; in *E. aconiatum*, Dietz, it is 1 : 3; in *E. oxyurum*, mihi, it is 1 : 4; in *E. agnatum*, Dietz, it is 1 : 5; and in *E. harveyanum*, mihi, it is 1 : 6.

ECHINOCHASMUS TENUICOLLIS, sp. nov. (Fig. 5.)

*Diagnosis*.—Small worms of slender form, with a slender neck. Collar spines twenty-seven. Ratio of oral to ventral sucker 1 : 5. Genital pore at the anterior edge of the ventral sucker. Testes three-lobed. Ovary on one side of the middle line. Uterus little coiled. Anteriorly the field of the yolk glands ends some distance behind the ventral sucker, and spreads over to the middle line behind the testes. Eggs  $0.084 \times 0.058$  mm.

*Host*.—The common Shag, *Phalacrocorax melanoleucus*, in the intestine.



Type specimen in the Australian Museum, Sydney, No. W. 431.

I obtained a large number of specimens of this little worm from the intestines of the Shag or black and white cormorant *Phalacrocorax melanoleucus*, near the Tuggerah Lakes, New South Wales.

It is a small form and varied little in size, the smallest measured being 3·134 mm. long by 0·52 mm. broad, the largest 4·05 mm. long by 0·59 mm. broad, while the average of a large number measured was  $3\cdot16 \times 0\cdot503$  mm. It is a rather delicate and slender form, broadest in the region of the ventral sucker. Behind this it becomes somewhat narrowed, and then gradually increases in width up to the region of the anterior testes, so that this region forms a kind of waist; behind this the sides of the body are fairly parallel till near the posterior end which becomes fairly suddenly rounded off. Between the head collar and the ventral sucker the body is slender, so that a very distinct, slender neck is present. On the ventral surface the neck region is fairly deeply concave. The integument is fairly thickly beset with small spines in the anterior part of the

body. Beginning at the extreme anterior end, these spines are very numerous down to the level of the ventral sucker, where they begin to thin out, and entirely vanish at the level of the ovary.

The head collar is well marked, with somewhat prominent ventral lobes or angles. It bears

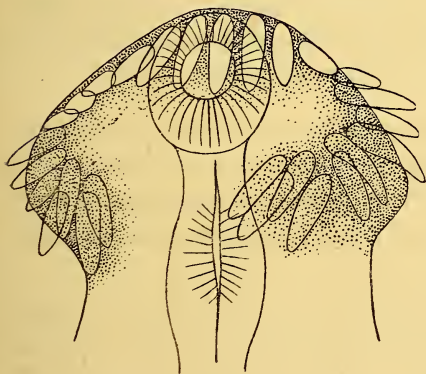


Fig. 10.—Head collar and spines of *Echinochasmus tenuicollis*.

twenty-seven spines altogether, an uninterrupted row of flat rod-like spines nineteen in number, with a group of four arranged in two pairs on each of the ventral angles (text fig. 10). They vary little in size (the smaller ones in the text figure are drawn fore-shortened) and measure  $0.069 \times 0.013$  mm. The oral sucker is bowl-shaped, rather broader than long ( $0.085 \times 0.107$  mm.) while the ventral sucker is very much larger  $0.504 \times 0.407$  mm., so that the ratio of the diameter of the oral to the ventral sucker is practically 1 : 5.

The distance between the suckers in specimens fixed in sublimate acetic is 0.543, little more than the length of the ventral sucker. In living specimens and in several preserved ones where the contraction, for some reason, was less marked, this space is much longer. There is a short prepharynx (0.08 mm.) and an oval muscular pharynx  $0.107 \times 0.28$  mm. The oesophagus, 0.277 is comparatively long. The bifurcation of the intestine lies anterior to the ventral sucker. The intestinal limbs quickly make their way to the sides of the body and terminate a little in front of the posterior end. The excretory vesicle is very voluminous and divides into two large collecting tubes at the posterior border of the testis, which are continued forwards right into the head collar. These vessels and their branches form a conspicuous feature in transverse sections.

The genital pore lies immediately in front of the anterior edge of the ventral sucker, to the centre of which the cirrus sac reaches back. The testes are triangular or three lobed, with the base of the triangle anterior and the apex pointing backwards.

They lie in the middle line and in the middle of the space between the ventral sucker and posterior end: but the exact position is variable a little, *e.g.*, in the specimen from which figure 5 was drawn they are a little nearer the

posterior end than the middle of the field. The size of the testes is considerable, but not so large comparatively as in some other members of the genus, (Nicoll<sup>(89)</sup>, fig. 7, and Dietz<sup>(13)</sup>, fig. 36). The anterior, 0.291 mm. broad and long is rather smaller than the posterior  $0.35 \times 0.31$  mm.

The ovary lies shortly in front of the anterior testis, on the right side of the middle line. It is nearly spherical in form,  $0.126 \times 0.116$  mm. in size. There is no receptaculum seminis, but the terminal part of the uterus is filled up with sperms, forming a receptaculum seminis uterinum. The space between the ovary and the testis is mainly taken up by the large gland of Mehlis. The uterus is little coiled and fairly long.

The yolk glands consist of very numerous small follicles varying in shape from spherical to oval, and in diameter from 0.027 to  $0.021 \times 0.018$  mm. In the extent of their field they differ from all the other members of this genus, for anteriorly they do not extend beyond a level halfway between the ovary and the ventral sucker. From this point they extend back in two lateral fields to the posterior testis, behind which they spread over to the middle line and almost reach the posterior extremity.

The eggs are large and showed little variation in size, the average measurement of a large number measured being  $0.084 \times 0.058$  mm.

The nearest relative of this worm, *E. coaxatus*, Dietz, is also parasitic in a water bird, the crested grebe, *Podiceps cristatus*. The two worms differ in a number of points. The collar spines of *E. coaxatus* are distinctly longer than those of *E. tenuicollis*. The relative size of the suckers is quite different, being 1 : 5 in the latter and 1 : 2 in the former. The shape of the testes is different, and the cirrus sac larger in the Australian form, but one of the most striking differences is in the stopping short of the yolk gland

fields some distance behind the ventral sucker. In this point, in the relative size of the testes, and in its more slender habit, it differs from *E. prosthovitellatus*, Nicoll, and *E. bursicola*, Crepl.

PATAGIFER ACUMINATUS, sp. n. (Figs. 2 and 3.)

*Diagnosis*.—Body slender, acuminate; head collar narrower than body, ratio of oral to ventral sucker 1:5. Intestinal fork lying dorsal to the ventral sucker; genital pore in front of intestinal fork; fields of the yolk glands narrow, not passing inwards beyond the intestinal limbs; eggs long and narrow,  $0.096 \times 0.043$  to  $0.107 \times 0.048$  mm.

*Host*.—*Ibis molucca*, in the intestine, Burnett River, Q.

Type specimen in the Australian Museum, Sydney, No. W. 432.

Nine specimens of this worm were obtained by Dr. Harvey Johnston from the intestine of the White Ibis, *Ibis molucca*. They varied in size from  $7.7 \times 1.012$  mm. up to  $10.45 \times 1.56$  mm. The body is deeply concave on the ventral surface behind the collar, and into this concavity the ventral sucker projects very prominently. When the thin sides of the body are spread out (and this is apt to be the case in a whole mount in balsam) this is the widest part of the body, but in the natural position of the parts, the widest part succeeds a "waist" at the posterior end of the ventral sucker. From this level the body tapers gradually to a long drawn out point so that it may be designated acuminate.

The collar is not so strongly developed as in *P. bilobus*, and is always less than the width of the body. The division or bay in its dorsal edge ends in front of the oral sucker, and the two dorsal lobes overlap; but there is a wide bay on the edge of the collar so that the two ventral angles are widely separated. There are twenty-five spines in a single row round the edge of the collar on each side. The



last in the dorsal bay is the smallest,  $0.0427 \times 0.0213$  mm. and they gradually increase in size to the fifteenth, in the vicinity of which a number are equal in size and measure  $0.122 \times 0.048$  mm. On each ventral angle there is a group of three spines not lying in series with the row round the edge and pointing obliquely inwards towards the middle line. The innermost, which is the largest, measures  $0.1602 \times 0.0534$  mm., the second  $0.1335 \times 0.0427$ , and the third which is much smaller than the others  $0.096 \times 0.026$  mm. All the collar spines have a flattened rod-like form, bluntly pointed at each end.

The integument of the body is entirely devoid of spines. The oral sucker is broader than long,  $0.194 \times 0.116$  in the smallest, and  $0.29 \times 0.232$  in the largest specimen. The ventral sucker measures  $0.97 \times 0.77$  mm. in the smallest, and  $1.55 \times 1.21$  mm. in the largest specimen, so that the ratio of the oral to the ventral is about 1:5. The pharynx is elongated oval, nearly twice as long as broad,  $0.175 \times 0.097$  mm. in the smallest, and  $0.31 \times 0.19$  mm. in the largest individual. The bifurcation of the intestine lies some distance behind the anterior edge of the ventral sucker.

The intestinal limbs immediately run straight out to the sides of the body, and course parallel to the sides of the body up to their termination near the posterior extremity.

The main stem of the excretory vesicle is very long and wide, and divides into two large arms just behind the posterior testis. The arms run forwards to the middle of the ventral sucker, giving off in their course, on the outer side, many branches.

The two large cerebral ganglia lie one on either side of the pharynx, immediately behind the oral sucker, and are joined together by a transverse commissure that passes on the dorsal side of the pharynx. The genital pore is situated

just behind the anterior edge of the ventral sucker, and some distance in front of the bifurcation of the intestine. The pear-shaped cirrus sac lies dorsal to the ventral sucker, reaching nearly to its posterior end. The testes lie in the anterior half of the body and overlap a little into the posterior half. They are slightly lobed elongated bodies about equal in size, the anterior measuring  $0.815 \times 0.582$  mm. and the posterior  $0.873 \times 0.524$  mm.

The spherical ovary is much smaller and lies some distance ( $0.388$  mm.) in front of the testes. It is median in position. The large gland of Mehlis lies just behind it. The uterus exhibits only a few transverse coils and then runs forwards in a wavy course to the genital opening.

The yolk-glands are confined to a narrow lateral field on each side, not extending inwards beyond the intestinal limbs and reaching from the ventral sucker to the extreme posterior end.

The follicles are very numerous, small, and oval,  $0.053 \times 0.027$  to  $0.08 \times 0.032$  mm.

The eggs are more than twice as long as broad,  $0.096 \times 0.043$  to  $0.107 \times 0.048$  mm.

*P. acuminatus* differs from *P. bilobus*, Rud., which is parasitic in *Ibis falcinellis* and *Platalea leucorodia* in the shape of its body and narrower collar, in having the genital pore situated in front of the intestinal fork instead of behind it as it is in *P. bilobus*; also in having the gonads further apart, in the narrower fields of its yolk-glands, in the fewer coils of the uterus and in its much narrower eggs.

The Australian form differs also from *P. consimilis*, Dietz, found in *Geronticus albicollis*, in Brazil, in its acuminate posterior end and more slender form; in having much larger spines on the collar, a smaller oral sucker, narrower yolk-gland fields and narrower eggs. The position of the

genital pore and the gonads in *P. consimilis*, Dietz has not been able to determine owing to his material being badly preserved.<sup>(13)</sup>

PATAGIFER FRATERNUS, sp. nov. (Fig. 4.)

*Diagnosis*.—Body linear, with sides parallel to behind the middle. Head collar as wide as the body. Ratio of oral to ventral sucker 1 : 6. Genital pore in front of the intestinal fork. Gonads close together; ovary oval, obliquely placed in the middle line. Eggs oval,  $0.107 \times 0.069$  mm.

*Host*.—*Herodias timoriensis*, in the intestine.

Type specimen in the Australian Museum, Sydney, No. W. 433.

Five specimens of this worm were obtained by Dr. Harvey Johnston from the intestine of the egret, *Herodias timoriensis*, at Burnett River, in Queensland. While it is fairly similar in most respects to *P. acuminatus*, and must be looked upon as closely related to that worm, it differs in detail in a number of respects.

The body is linear with the sides parallel in the anterior two-thirds; behind this it tapers to a point. The average size is over 10 mm. long by more than 1.25 broad. The largest specimen measured  $11.75 \times 1.44$  mm. The head collar is as wide as the body; its dorsal bay is wide and gaping. There are twenty-eight collar spines in a single row on each side, being very small in the dorsal bay and large laterally. The spines along the lateral border ( $0.144 \times 0.04$  mm.) are longer than those of *P. acuminatus*. In the ventral corners, on the inner surface of the collar, on each side there lies a group of four spines not in series with those running round the edge. They point in towards the middle line and are placed further back from the edge than the others. Two are large  $0.128 \times 0.054$  mm., and two

very small. The oral sucker measures 0.291 mm. in diameter, only one-sixth of the ventral, which is 1.75 mm. long by 0.97 mm. broad. The suckers are 0.77 mm. apart. The fork of the intestine is just on a level with the anterior edge of the ventral sucker, and the genital pore stands a little (0.02 mm.) in front of this.

The testes are large oval bodies with indented edges lying close together in the middle of the body, close to them the oval ovary lies in the middle line, but obliquely disposed. The two testes are equal in size and measure  $1.028 \times 0.485$  mm. The ovary,  $0.388 \times 0.291$  mm., is much smaller. The proximal part of the uterus is dilated to form a relatively very large receptaculum seminis uterinum, which lies for the most part posterior to the ovary and gland of Mehlis. The eggs are relatively broader than in *P. acuminatus*, measuring  $0.107 \times 0.069$  mm.

Subfamily PLAGIORCHINÆ (Lepodermatinæ).

PLAGIORCHIS SPATULATUS, sp. n. (Fig. 11.)

*Diagnosis*.—Body spathulate and flat; size small, less than 1 mm. long. Integument spiny. Suckers large, oral greater than the ventral. Testes *equal in size, lying one behind the other* in the posterior half of the body. Ovary in front of posterior testis. The three gonads separated by loops of uterus. Yolk glands in the lateral fields; *not crossing the intestinal limbs except behind the testes*. Eggs  $0.031 \times 0.017$  mm.

*Host*.—*Anthus australis*, in the intestine.

Type specimen in the Australian Museum, No. W. 434.

The specimens of this worm in my possession were collected by my friend Dr. T. Harvey Johnston, of the University of Queensland, at Caloundra in that State. It was obtained from the intestine of the Australian Pipit, *Anthus australis*, and is quite a small worm, flat and



spatula-like in form, rather less than a millimetre long, and a little more than one-third of a millimetre broad.

The largest specimen measured was 0·99 mm. long, and 0·39 mm. broad, while the smallest was 0·815 mm. long, and 0·349 mm. broad. The body reaches its greatest breadth in the region of the testes and is very bluntly pointed at each end.

The integument at the anterior end is thickly covered by small, backwardly directed spines. The suckers are comparatively large, especially the oral (0·161 mm. in diameter) which is considerably larger than the ventral (0·133 mm.). The pharynx is also comparatively large (0·075 mm.) and muscular, but the œsophagus is very short. From its posterior end the limbs of the intestine run out towards the sides for some distance, then bend sharply through a right-angle and course backwards parallel to the lateral edges of the body, ending a short distance in front of the posterior end.

The excretory pore is placed at the extremity of the body and leads into an elongated vesicle which runs forwards, passing between the testes on the dorsal side of the body. At about the level of the ovary it bifurcates into two branches.

The genital pore lies just in front of the ventral sucker, near the middle line. The testes are equal in size, large and oval 0·138 mm. long, and 0·117 mm. broad. They are obliquely placed one behind the other, the right being posterior. The ovary is nearly spherical and smaller than the testes, 0·085 mm. in diameter, lying on the right side, at a level just in front of the anterior testis but behind the ventral sucker.

The cirrus sac is very elongated and tubular, extending from the anterior testis to the genital opening, curving round on the dorsal and right side of the ventral sucker.

The vesicula seminalis lying within it is not coiled. The uterus has a descending limb running backwards between the testes to a point near the posterior ends of the intestinal limbs. From this point it bends sharply round and runs forward in a number of close coils, again passing between the testes on its way towards the genital opening. Its terminal part which is thick-walled and muscular, may be distinguished as the vagina. The uterine coils fill up the field between the intestinal limbs behind the testes. A receptaculum seminis and Laurer's canal are absent. The yolk glands consist of very numerous, small, rounded follicles 0.011 to 0.014 mm. in diameter. In front they are confined to the space between the intestinal limbs and the lateral edges of the body, but behind the testes the field of these glands widens out, crossing over the intestinal limbs and invading the space between them to a certain extent.

The average size of the eggs is  $0.031 \times 0.017$  mm., the largest being 0.033 mm., and the smallest 0.029 mm. long, while the breadth remains practically constant.

In its structure this species appears to resemble more closely than other species, *P. maculosus*, Rud., parasitic in various species of swallows (*Hirundo*) in Europe.

PLAGIORCHIS CLELANDI, sp. n. (Fig. 11a.)

*Diagnosis*.—Small worms, with sides parallel for the most part and the body narrowed towards each end. Integument in the anterior end covered with small scale-like spines. Suckers almost equal in size. Intestinal limbs *wide and voluminous*. Yolk-glands *closely surrounding* the intestinal limbs and not extending inwards; anteriorly they only reach a point half-way between the pharynx and the ventral sucker.

*Host*.—The Fairy Martin, *Petrochelidon ariel*.

Type specimen in the Australian Museum, Sydney, No. W. 435.

A dozen of these small worms were obtained from the intestine of a Fairy Martin (*Petrochelidon ariel*), at Gular in New South Wales, by Dr. J. B. Cleland of the Government Bureau of Microbiology, N.S.W. The worms are quite small, averaging only 2 mm. long by 0.5 mm. wide. The largest measured  $2.19 \times 0.65$  mm. The body is flat with the sides parallel for the greater part of the length, but tapering at each end into a blunt rounded point. At the anterior end the integument is covered by small half-moon shaped scales. The oral sucker, which is situated on the ventral side of the body, is a little longer than broad,  $0.291 \times 0.252$  mm. The ventral sucker, lying in the middle of the second quarter of the body length is circular in form, with a diameter of 0.252, equal to the transverse diameter of the oral sucker. A distinct prepharynx is present, with a globular pharynx 0.112 mm. in diameter.

There is practically no oesophagus and the intestinal limbs are wide and stretch nearly to the posterior end. The genital pore lies just in front of the ventral sucker, in the middle line or a little to one side. The cirrus sac is very elongated, C-shaped, and beginning at the anterior testis curves round the ventral sucker on one side and in front to reach the genital pore.

The testes are large oval bodies placed obliquely one somewhat in front of the other, the anterior,  $0.31 \times 0.29$  mm. a little smaller than the posterior  $0.369 \times 0.29$  mm. The ovary which is also comparatively large, lies on one side of the middle line in front of the posterior testis on a level immediately behind the ventral sucker. It measures  $0.233 \times 0.175$  mm., and its long axis is transversely placed.

The yolk-glands, consisting of comparatively large oval follicles  $0.043 \times 0.037$  mm., surround the voluminous intestinal limbs; anteriorly they extend to a level half-way between the pharynx and the ventral sucker, and cover

the intestinal limbs right to their posterior end. They do not extend inwards beyond the intestine to any appreciable extent, and remain separated behind.

The uterus is very thin-walled and occupies the middle field behind the testes almost reaching the posterior end of the intestine. One coil runs between the testes on the dorsal side, and between the testes and the ovary.

The eggs are comparatively numerous and quite small, the average size being  $0.032 \times 0.019$  mm., while the smallest measured  $0.0304 \times 3.017$  mm., and the largest  $0.033 \times 0.022$  mm.

*Plagiorchis clelandi* is more closely related to *P. maculosus*, Rud., parasitic in the European swallow, *Hirundo*, than to the other species of the genus. It differs from this species mainly in the arrangement of the fields of the yolk-glands, which in Australian species never extend as far forwards as the fork of the intestine, indeed only reach a level half-way between the ventral sucker and the pharynx, and which always remain separate in the posterior region. The eggs in the Australian form are smaller than those of the European.

*P. clelandi* differs from the other Australian species of the same genus *P. spatulatus*, mihi. and *P. (Lepoderma) nisbetii*, Nicoll,<sup>(38)</sup> in a number of points such as the very closely placed gonads, but especially in the extent of the yolk-gland fields which extend further forward in the two last named species and in *P. spatulatus* in addition are more lateral in front of the testes and extend further in towards the middle behind them.

DOLICHOSACCUS SOLECARIUS, sp. n. (Fig. 12.)

*Diagnosis*.—A minute worm, cylindrical in form, with large suckers. *Ratio of oral to ventral sucker* 3 : 2. Integument spiny, except at the posterior end. Prepharynx,



pharynx and œsophagus present. Intestinal limbs wide and voluminous. Genital pore just in front of ventral sucker. Cirrus-sac long and wide containing a voluminous vesicula seminalis constricted in its middle. Ovary *some distance* behind the ventral sucker. Testes one behind the other, in the *posterior body-third*. Yolk-gland extending from ventral sucker to end of intestinal limbs, not extending inwards beyond the intestinal limbs.

*Host*.—*Phalacrocorax melanoleucus*, in the intestine.

Type specimen in the Australian Museum, Sydney, No. W. 436.

A single specimen of this little worm was found in the intestine of a shag, *Phalacrocorax melanoleucus* at Tuggerah Lakes. It is only 1·1 mm. long and 0·184 mm. broad. It is cylindrical in shape, of even diameter throughout almost its whole length, being bluntly rounded off at each end. The anterior part of the body as far back as the "shell-gland" is densely covered with small spines. Behind the "shell-gland" they become a little less dense, and end abruptly at the level of the anterior testis. The oral sucker is circular in form and comparatively very large, almost as wide as the body. Its diameter is 0·1602 mm. The ventral sucker also circular, is situated in the beginning of the middle third of the body. Its diameter is 0·1068, so that the ratio of the oral to the ventral sucker is 3 : 2.

There is a very distinct prepharynx, 0·032 mm. long. The pharynx is globular, with thick muscular walls, and has a length of 0·064 mm. The œsophagus 0·032 mm. long is only half as long as the pharynx. The intestinal limbs are wide (0·048 mm.) and voluminous, and run back to the posterior end of the body, nearer to the middle line than to the sides of the body.

The cirrus sac is long (0·24 mm.) and wide, and contains a voluminous vesicula seminalis, constricted in its middle.

It extends back as far as the ovary. The vesicula seminalis is filled with sperms. The genital pore lies in the middle line a little in front of the ventral sucker.

The ovary is a conspicuous oval structure,  $0.069 \times 0.058$  mm., lying some distance behind the ventral sucker and to one side of the middle line. A large "shell-gland" lies immediately behind it. The testes lie in the posterior third of the body, close together, one behind the other in the middle line. They are oval in shape, with the long axis longitudinal, and the anterior ( $0.096 \times 0.0801$  mm.) is slightly smaller than the posterior ( $0.106 \times 0.0801$  mm.). The yolk-glands consist of very small, rounded follicles  $0.014$  mm. in diameter. They extend from the anterior border of the ventral sucker to the posterior end of the intestine. As far back as the ovary they are confined to the lateral fields lying between the intestinal limbs and the sides of the body, but behind the ovary they spread out on the ventral surface of the intestinal limbs, but do not anywhere extend inwards towards the middle line beyond the inner edges of the intestine. The uterus is short and does not extend back beyond the shell-gland. There is a long Laurer's canal. The uterus contains no eggs, though the ovary has every appearance of being mature, and the vesicula seminalis is filled with sperms.

The other species of *Dolichosaccus*<sup>(21)</sup> are parasitic in Frogs and do not seem to be very closely related to the the present species, which indeed, with some doubts, I include in this genus. It differs from the three species from frogs in its cylindrical form, in the relative size of the two suckers and in the topography of the fields of the yolk-glands.

Subfamily MICROPHALLINÆ.

LEVINSENIELLA HOWENSIS, sp. n. (Fig. 13.)

*Diagnosis*.—Minute worms, rather less than a millimetre long; elongated pear-shaped, flattened dorso-ventrally.

Integument spiny. Suckers *equal in size*; the ventral far back in the posterior region of the body. Very long *pre-pharynx* and oesophagus. Intestinal limbs moderately long, *wavy, without diverticula*. Genital pore on a level with the ventral sucker on the left side.

Testes symmetrically placed, one on either side, behind the ventral sucker. Ovary on a level with the ventral sucker. Eggs very small.

*Host*.—*Charadrius dominicus*, in the cæcum.

Type specimen in the Australian Museum, Sydney, No. W. 437.

A very large number of these minute worms were obtained by Dr. Harvey Johnston from the cæcum of *Charadrius dominicus* at Lord Howe Island. They vary in length from 0·77 to 1·07 mm.

The specimen from which figure 13 was drawn, which is fairly typical in size and shape, except that the body is a little wider than usual in the region of the intestinal bifurcation, measured 0·97 mm. long by 0·194 mm. wide at the level of the pharynx and 0·368 mm. in the widest part of the body, in the region of the testes. The worms are elongated pear-shaped, and flattened dorso-ventrally. The integument in the anterior part of the body in front of the intestinal fork is densely covered by small spines.

From that level they gradually become more scattered right back to the posterior end. The oral sucker is situated on the ventral surface at the narrow end of the body; the ventral sucker is far back, lying in the posterior quarter of the body length. Both the suckers are circular in form and exactly equal in size, varying from 0·064 to 0·074 mm. in diameter. The pharynx is well marked, and owing to its isolated position, a conspicuous structure in whole mounts. It measures 0·048 × 0·042 mm. In front of it

and behind it lie the prepharynx and œsophagus respectively, exactly equal and conspicuous for their length, varying in different specimens from 0·079 to 0·107 in length. The intestinal limbs are wide and without cæca, but pursue a wavy course, gradually diverging from the middle line to the level of the ventral sucker.

Branched excretory vessels run back along the sides of the body to join the V-shaped excretory vesicle. The genital pore is situated on the left side of the ventral sucker, about its middle. There is a voluminous cirrus-sac and pars prostatica, and the copulatory bursa is rather smaller than in the other species of this genus. The gonads are all oval and have their long axes placed transversely, the ovary on a level with the ventral sucker and to its right; the testes symmetrically one on either side of the middle line. The testes are equal in size,  $0\cdot107 \times 0\cdot08$  mm.; the ovary is smaller,  $0\cdot08 \times 0\cdot053$  mm.

The yolk glands are arranged in three main groups of follicles on each side, and in whole mounts are a good deal concealed by coils of the uterus, which forms a number of loops in the posterior part of the body behind the testes. The eggs are very small and oval, varying from  $0\cdot017 \times 0\cdot0138$  up to  $0\cdot018 \times 0\cdot0138$  mm.

This pretty little worm seems to be most closely related to Jägerskiöld's *L. brachysoma*<sup>(15)</sup> parasitic in the cæcum of a bird of the same genus in Scandinavia, namely *Charadrius hiaticula*. It differs from this species, however, in its more elongated and slender form; and in the ratio of the suckers to one another. In the present species they are exactly equal, while in *L. brachysoma*, Jag. the oral is twenty per cent. larger than the ventral.<sup>(15, p. 140)</sup> The pharynx is smaller in *L. howensis* and the limbs of the intestine are without cæca. While on the whole, the arrangement and structure of the genital organs are pretty much the same in these



two species; in *L. howensis* the male bursa copulatrix is considerably smaller. The eggs also are a good deal smaller in the Australian form.

Subfamily DICROCÆLIINÆ.

LYPEROSOMUM PARVUM, sp. n. (Fig. 14.)

*Diagnosis*.—Elongated, cylindrical; suckers large, oral rather smaller than the ventral, œsophagus short; intestinal limbs reaching posterior end. Testes placed close together and just behind the ventral sucker. Genital opening in front of, but close to the ventral sucker; cirrus sac lying mainly dorsal to the ventral sucker; vesicula seminalis much coiled. Ovary behind and close to the posterior sucker. Yolk glands consisting of a few large follicles in two rows behind the ovary. Uterus very extensive. Eggs thick shelled,  $0.039 \times 0.023$  mm.

*Host*.—*Strepera versicolor*, in the intestine.

Type specimen in the Australian Museum, No. W. 438.

This species is represented by a number of small trematodes collected at Rydal, New South Wales, by my friend Dr. S. J. H. Moreau, from the intestine of the grey crow-shrike, *Strepera versicolor*.

This species is much smaller than any *Lyperosomum* hitherto described, having a length of 3.6 mm., and breadth of 0.37 mm. The body is almost cylindrical, but only slightly flattened towards the posterior end. The suckers are rather longer than broad, the oral ( $0.213 \times 0.194$  mm.) being smaller than the ventral ( $0.252 \times 0.233$  mm.). The pharynx, broader than long ( $0.054 \times 0.08$  mm.), is very much smaller than the suckers. There is a short œsophagus, ending a little in front of the ventral sucker, and the two intestinal limbs, which are narrow and unbranched, run back to the posterior end of the body. The genital opening is situated in the middle line in front of, and close to the

anterior edge of the ventral sucker. The cirrus sac is well developed and entirely surrounds the much coiled vesicula seminalis. Its position, relative to the ventral sucker, is more posterior than in the other species of *Lypermomum*, lying as it does almost entirely behind the anterior edge of the ventral sucker, only reaching in front of it where it passes forwards to reach the genital opening. The testes, which lie close together, one behind the other, are separated from the ventral sucker by a couple of coils of the uterus. They are almost cubical in form, smooth edged and very large, stretching right across the body, only leaving a small amount of room for a coil of the uterus to pass on their dorsal aspect. They are approximately equal in size,  $0.35 \times 0.27$  mm.

The ovary, which lies close behind the posterior testis, is much smaller, measuring  $0.194 \times 0.116$  mm. It is oval in form and has its long axis transversely placed. Posterior to the ovary and in the dorsal region of the body, the receptaculum seminis and gland of Mehlis or "shell-gland" are found. The yolk glands consist of a few (16 to 18) large oval follicles measuring  $0.08 \times 0.07$  mm. They are arranged roughly in two rows and extend backwards from the posterior aspect of the ovary for a distance of rather more than half a millimetre. The uterus is very extensive, and in whole mounts serves to hide the other organs a good deal. In a number of closely packed coils it extends backwards to the extreme posterior end of the body. From this point it runs forwards in much looser coils on the ventral aspect of the body as far as the posterior testis, where it passes to the posterior side by making a coil between the ovary and the testis. It partly separates the testes by a short coil and throws two thick coils in between the anterior testis and the cirrus sac.

The eggs, especially those in the distal or ascending coils of the uterus, are very dark brown in colour, oval in shape,

and very thick shelled. The eggs differed in size a little according to their position in the uterus, the smallest measuring  $0.037 \times 0.021$  mm., the largest  $0.043 \times 0.026$  mm., while the average of all those measured was  $0.039 \times 0.023$  mm.

Comparing it with forms previously known, this species seems to be nearly related to *Lyperosomum lobatum*, Raill. from *Pica caudata*, and to an unnamed species in von Linstow's collection, figured by Braun in <sup>(10, fig. 66)</sup>. The latter is a parasite of *Corvus corone*.

LYPEROSOMUM MEGASTOMUM, sp. n. (Fig. 15).

*Diagnosis*.—Form elongated, cylindrical. Suckers very large, *wider than the body*, oral smaller than the ventral. Testes large, approximately equal, close together, a short distance behind the ventral sucker. Genital pore in front of intestinal fork; cirrus sac lying mainly *anterior to the ventral sucker*, ovary oval, half as large as testes, long axis transversely placed. Yolk glands consisting of few, large follicles, occupying a short field behind ovary; uterus very extensive, filling up posterior two-thirds of body. Eggs large,  $0.038 \times 0.023$  mm.

*Host*.—Crested tern, *Sterna bergii* in the intestine. Locality: Tuggerah, N.S.W.

Type specimen in the Australian Museum, Sydney, No. W. 439.

The most striking character of this species is the size of the suckers which considerably exceed the narrow cylindrical body. The worms are about the same length as *L. parvum* (3.68 mm. on the average) but are much more slender, being only 0.194 mm., in breadth at the level of the testes, and 0.145 mm., in the region of the uterus. Both the suckers exceed this breadth in their diameter and so project beyond the lateral edges of the body. The oral

sucker 0.203 mm. in diameter, is rather smaller than the ventral (0.239 mm.). The œsophagus is short (0.144 mm.) and the intestinal limbs very narrow. The genital pore lies nearer the anterior end than usual in other species, being nearer the oral than the ventral sucker. The cirrus sac, with the contained vesicula seminalis, lies mainly anterior to the ventral sucker, but with its base projecting backwards for a short distance behind the anterior edge of it. The testes are large and oval with the long axis longitudinal, while the oval ovary has its long axis transversely placed. The three gonads are placed close together in a line, one behind the other, without any loops of the uterus separating them. The posterior testis is always slightly smaller than the anterior, the measurements being  $0.214 \times 0.161$  mm., and  $0.239 \times 0.171$  mm., respectively. The ovary is considerably smaller,  $0.107 \times 0.161$  mm. The receptaculum seminis and gland of Mehlis lie just posterior to the ovary.

The yolk glands, as in *L. parvum*, are few and large, occupying a short field in the body immediately behind the ovary. They are arranged in an irregular double row and are greatly obscured from view by the uterus filled with eggs. The whole of the posterior part of the body is taken up by the folds of the uterus.

The eggs are large, the largest measured being  $0.041 \times 0.024$  mm., the smallest  $0.037 \times 0.021$  mm., while the average of a large number measured was  $0.038 \times 0.023$  mm.

#### LYPEROSOMUM HARRISONI, sp. n.

*Diagnosis.*—Elongate, cylindrical; suckers large, but not so wide as the body, oral sucker smaller than the ventral. Testes large, oval in shape; posterior larger than anterior; ovary oval. Long axis of both testes and ovary transversely placed. Genital pore midway between the



suckers. Cirrus sac mostly in front of ventral sucker, but part dorsal to it. Coils of the uterus lying *between the testes and between the second testis and ovary*. Yolk glands of few, large follicles. Eggs  $0.038 \times 0.024$  mm.

*Host*.—The boobook owl, *Ninox boobook*.

Type specimen in the Australian Museum, No. W. 440.

A small number of specimens from the boobook owl were given me by my colleague Mr. Launcelot Harrison, who obtained them from the intestine of an owl, secured at Lindfield, near Sydney. This species is similar in size to *L. parvum*. The oral sucker, 0.223 mm. in diameter, is smaller than the ventral, 0.262 mm. The testes are broader than long, and the anterior (0.33 mm. broad by 0.25 mm. long) is smaller than the posterior (0.33 mm. broad by 0.29 mm. long). The testes are separated from one another and from the ovary behind them by wide coils of uterus. The genital pore lies midway between the two suckers; most of the cirrus sac lies in front of the ventral sucker and the vesicula seminalis is coiled.

The yolk glands consist of twelve to fourteen large, oval follicles arranged in two rows in the field behind the ovary. The uterus, as usual, is very extensive, obscuring the yolk glands and occupying the whole field of the body posterior to them. The eggs which are light yellow in the proximal part, become dark brown in the distal part of the uterus. They measure  $0.038 \times 0.024$  mm., and are very even in size.

This species is closely related to *L. parvum*. Indeed all three species, described here for the first time, are closely related to one another.

#### Subfamily HARMOSTOMINÆ.

##### HARMOSTOMUM PULCHELLUM, sp. n. (Fig. 16.)

*Diagnosis*.—Size moderate, body cylindrical and pointed at each end. Spines absent. Oral sucker little larger than

the ventral. Pharynx conspicuous; œsophagus wanting. Gonads not so close together as usual in *Harmostomum*. Cirrus sac rudimentary, not enclosing vesicula seminalis. Field of the yolk glands extending from *posterior border of ventral sucker to posterior border of the ovary*. Coils of the ascending loop of the uterus *extending laterally beyond the intestinal limbs*. Eggs 0·028 mm. long by 0·015 mm. broad.

*Host*.—The Wonga Pigeon, *Leucosarcia picata*, North Western New South Wales.

Type specimen in the Australian Museum, No. W. 441.

These specimens were obtained by Dr. T. Harvey Johnston of the University of Queensland, at Moree in north-western New South Wales. They vary a good deal in size, the smallest being 2·75 mm. long by 0·45 mm. broad, while the largest measured 5 mm. long by 0·78 mm. broad, the average length of half a dozen being 4 mm. The form is cylindrical, with the sides of the body parallel except at the ends which are somewhat pointed, especially the posterior end. Spines appear to be completely absent, as I could not find any trace of them either in the whole mounts or sections.

The outline of the suckers is fairly circular and they are approximately equal in size, though sometimes the oral, which is on the ventral aspect of the worm, is a little larger than the ventral, *e.g.*, 0·291 mm. : 0·271 mm. The suckers are a considerable distance apart, for the ventral sucker stands at the beginning of the middle third of the body. The pharynx is conspicuous, measuring, in the same animal on which the two measurements just mentioned were made, 0·135 × 0·155 mm. There is practically no œsophagus, as the two intestinal limbs open directly into the pharynx. The intestinal limbs show the characteristic feature of *Harmostomum* in the shape of the short loop running forwards towards the oral sucker on each side of

the pharynx. But instead of running backwards near the edges of the body they course much nearer the middle line, especially in the middle third of the body. They are not straight but thrown into a number of waves.

The genital pore is in the middle line, just in front of the anterior testis, at the junction of the middle and posterior thirds of the body. From the genital opening, the male duct leads at first directly forwards, through the rudimentary cirrus sac, and then bends sharply back and runs towards the testes. This part of the duct is the vesicula seminalis; and, just in the region where the bend occurs, a number of prostate cells are attached to it, with their bodies lying free in the parenchyma; only the anterior end of the vesicula seminalis, where it joins the ejaculatory duct lies within the cirrus sac.

The testes are large and some distance apart, with a distinct space between them and the ovary, which lies between and somewhat to one side of the middle line. The posterior testis is always more elongated than the anterior, measuring, in a specimen 4.75 mm. long, 0.582 mm.  $\times$  0.291 mm., while the latter measures 0.427  $\times$  0.33 mm. The long axis of the posterior testis lies longitudinally, while that of the anterior is rather oblique. The ovary is also oval in shape, measuring in the same worm 0.291  $\times$  0.232 mm.

The ascending loop of the uterus is thrown into a number of transverse coils which pass outwards beyond the intestinal limbs into the field in which the yolk glands lie. The latter consist of a large number of small follicles arranged in two elongated fields, extending from the posterior edge of the ventral sucker in front to the posterior edge of the ovary behind. They do not cross over the intestinal limbs, but are confined to the space between these limbs and the lateral edges of the body.

The eggs are very small, narrow and pointed at the ends. The largest measured were  $0\cdot032 \times 0\cdot016$  mm., the smallest  $0\cdot027 \times 0\cdot013$  mm., while the average of a large number measured was  $0\cdot028 \times 0\cdot015$  mm.

This differs from the other species of *Harmostomum* found in birds, e.g., *H. mordens*, *H. fuscata*, *H. caudale*, and *H. centrodes*<sup>(10)</sup> in the position and extent of the yolk glands fields, the more median position of the intestinal limbs and the crossing of the uterine coils into the lateral fields beyond the intestinal limbs. All these differences are of course correlated with one another.

Subfamily CLINOSTOMINÆ.

CLINOSTOMUM AUSTRALIENSE, sp. n. (Fig. 17.)

*Diagnosis*.—Large form, widest in the region of the gonads. Oral field well developed. Suckers very large and close together. Intestinal limbs provided with side branches. Genital pore in the middle line. Cirrus sac alongside the anterior testis. Cirrus spiny.

*Host*.—*Plotus novæ-hollandiæ*, in the œsophagus.

Type specimen in the Australian Museum, No. W. 442.

Locality, Burnett River, Queensland.

Two specimens of this species of *Clinostomum* were obtained from the œsophagus of the Darter, *Plotus novæ-hollandiæ*, by Dr. Harvey Johnston. One was mounted whole, the other cut into horizontal sections. It is a fairly large form 11 mm, long by 3·25 mm. broad at the widest part, in the region of the gonads. It is fairly thick. The oral field is fairly well marked. The body is constricted at the level of the ventral sucker, and from this point gradually increases in width to the region of the gonads, whence it again becomes narrowed towards the posterior end, which is sharply truncated. The anterior end is also



truncated. The cuticle is beset with numerous fine spines which scarcely project on the surface and are only to be seen in sections.

The suckers are large and strong, especially the ventral, which is more than twice as large as the oral. They are both circular in outline, the latter 0.54 mm. in diameter, the former 1.26 mm. They are separated by an interval of 0.75 mm.

*Alimentary canal.*—There is no pharynx of the usual form found in trematodes, but the wall of the œsophagus, tubular in form, is provided with muscular layers. There is an outer layer of circular and an inner layer of longitudinal fibres. Both these muscular sheets are directly continuous with similarly arranged layers in the oral sucker, though the well marked and thick layer of radial fibres present in the sucker appears to be absent from the œsophagus. MacCallum mentions<sup>(34, p. 699)</sup> that “the musculature of the (oral) sucker is composed of three layers, meridional, radial, and equatorial or arcuate. The pharynx similarly constructed and provided with a thick cuticular lining,” etc. This corresponds pretty closely with what I find in *C. australiense*, except that, in the absence of the usual barrel-shaped pharynx with thick muscular walls, I prefer to call the tubular structure with thin sheets of muscular tissue in its walls “the œsophagus.” Braun<sup>(8, p. 8)</sup> seems to view MacCallum’s statement about the muscular layers with some doubt, but my finding them in the form under investigation here may be looked upon as confirmation of MacCallum’s observations.

From the œsophagus the intestinal limbs are directed at first laterally, and reach a point halfway between the middle line and the side of the body. Here a sharp turn is made to run backwards more or less parallel to the sides of the body, the two limbs coming nearly together at a point just

in front of the excretory vesicle. The two limbs are provided on each side with short diverticula.

*Excretory system.*—The form of the excretory system is peculiar and highly characteristic. A short V-shaped vesicle, opening by the excretory pore at the posterior end, gives off on each side a very large collecting vessel, which runs forwards, about halfway between the intestinal limbs and the sides of the body, right up into the region of the oral field. Each of these collecting vessels is joined on either side by vessels which form anastomosing loops, that cover the whole dorsal surface of the body. In *Clinostomum marginatum* this part of the excretory system (Osborn, figs. 3 and 4) lies ventral to the intestinal limbs, but in my form they are undoubtedly dorsal. These anastomosing loops communicate with a very extensive system of sub-cuticular spaces and channels, as they do also in *C. marginatum*. I have not been able to trace the fine recurrent vessel described by Osborn in *C. marginatum*, but cannot say definitely that it is not present, as I have only one series of horizontal (parallel to the ventral surface) sections, and in such a series its connection with the collecting tubules would be particularly difficult to demonstrate.

*Nervous system.*—A pair of large cerebral ganglia lie one on each side of the œsophagus, on the dorsal side of which the transverse connecting commissure passes. Besides the thick nerve cords which run back to the posterior end almost in a line with and ventral to the main collecting vessels of the excretory system, a number of pairs of small nerves are given off by the cerebral ganglia to neighbouring parts.

*Genital system.*—The gonads lie in the posterior third of the body, the anterior testis projecting a little into the middle third. The testes are roughly triangular, with deep

indentations along the margins. The anterior measures  $0.78 \times 0.69$  mm., and is almost entirely on the left side of the middle line, the opposite side being occupied by the comparatively large cirrus sac, which lies alongside it. The posterior testis lies with its base anterior and apex posterior, the base being somewhat concave.

The testes are 0.5 mm. apart, and in the space between them is found the ovary ( $0.33 \times 0.252$  mm.), on the right side, oval in shape, and with an entire outline and some coils of the oviduct including the ootype etc. There is a short Laurer's canal opening near the middle line on the dorsal surface, but no receptaculum seminalis. The gland of Mehlis surrounds the ootype. The comparatively conspicuous vasa deferentia become joined to enter at once the coiled vesicula seminalis, which is completely enclosed within the cirrus sac. This leads to a well-marked genital atrium with a conspicuous opening in the middle line, on a level with the anterior edge of the anterior testis. The terminal part of the duct of the cirrus is lined by a number of chitinous tubercles or blunt spines.

The oviduct, after making a number of coils in the space between the testes, curves round the left border of the anterior testis and just in front of it opens into the uterine sac. The latter is a conspicuous object even in the whole mount, and reaches forwards as far as the junction between the anterior and middle third of the body. The uterine sac opens into the genital atrium some distance behind the point at which it is joined by the oviduct. Neither the uterine sac nor the oviduct, in either specimen, contained any eggs, so that I infer the specimens were not quite sexually mature, though the vesicula seminalis was filled with sperms. The immaturity of the specimen was also shown by the state of the yolk glands, which had only just begun to make their appearance, and occupied a small field behind and to the right of the gonads.

This species of *Clinostomum* seems to be more closely related to *C. marginatum*<sup>(44)</sup> than to any other species. They are fairly similar in external form but the Australian species is larger, and the ventral sucker is relatively further forward in the body. The position of the cirrus sac is different, being alongside the anterior testis, and not at all in front of it. The cirrus of *C. marginatum* does not appear to be spiny since Osborn makes no mention of this feature.

*C. australiense* differs from *C. hornum*, Nicoll<sup>(39)</sup> in size and shape, in the position of the genital pore (it is removed from the middle line in the latter) in having the ventral sucker nearer the anterior end and in having side branches to the intestinal limbs.

**Family BILHARZIIDÆ Odhner, (SCHISTOSOMIDÆ).**

AUSTROBILHARZIA TERRIGALENSIS, gen. et sp. nov.

(Figs. 18—22.)

*Diagnosis.*—Male shorter than the female, the gynecophoral canal extending from the hinder border of the ventral sucker to the posterior end of the body. Suckers well developed and prominent. Œsophagus ending at or a little in front of the ventral sucker; the paired intestinal limbs running backwards without any connecting commissure to the last quarter of the body where four commissures occur, followed by a short, terminal, unpaired section of gut.

Testes consisting of about *eighteen to twenty rounded follicles* lying one behind the other, symmetrically placed between the intestinal limbs, beginning anteriorly a little behind the ventral sucker and extending backwards to the middle of the body. Genital pore situated towards the left side a little behind the ventral sucker. Cirrus sac present, enclosing the *vesicula seminalis*: prostate present.

*Female* considerably longer than the male, the anterior part rounded and thread-like, the posterior part, in which the ovary and yolk glands lie, flattened and much broader.



*Spines absent*, ventral sucker present. Ovary comparatively long, tubular and bent into a series of *five or six waves* or loops. Yolk glands occupying the posterior third of the body.

Type species *A. terrigalensis*, sp. n.

*Host*.—*Larus novæ-hollandiæ*.

Type specimens in the Australian Museum, Sydney, No. W. 443.

In a gull, *Larus novæ-hollandiæ*, shot at Terrigal, New South Wales, I found in the intestine a number of small worms each surrounded by a droplet of blood. These proved to be Bilharzia-like forms which probably escaped through a wound from the intestinal blood vessels into the intestine. In most cases the female was found to be occupying the gynecophoral canal of the male. Though fairly closely related to *Ornithobilharzia* they proved to belong to none of the already established genera of this family, so that I propose for their reception a new genus *Austrobilharzia*.

In *Austrobilharzia terrigalensis* the males average 4 mm. in length, while the females are 5 mm. or a little longer. The shortest male measured 3·5 mm., and the female with it 4·5 mm. in length. In many cases it was not possible to measure the length of the female exactly, owing to its anterior thread-like part being bent into a number of waves. Spines were quite absent from the integument of both sexes except on the inner surface of the ventral sucker of the male where very small fine spines occurred. Both the oral and the ventral suckers of the male are well marked off from the surface of the body, the latter especially so, for it is distinctly stalked (fig. 20). The suckers are approximately equal and show very little variation in size, the diameter being 0·175 mm. In all the males the body exhibits a marked antero-posterior curva-

ture towards the ventral side, so that the shape of the body viewed from the side is like an open C (fig. 18 and 19). The average breadth of the male viewed from the side and measured from the lateral border, forming the boundary of the gynecophoral canal, to the middle of the dorsal surface is 0.4 mm. The gynecophoral canal is deep, and is wrapped round the female (fig. 22). The limbs of the intestine, both the paired and unpaired tracts, are beset with numerous short diverticula throughout their whole length. The four commissures form two small loops which are connected by an unpaired piece. Behind the second loop the intestine proceeds to the posterior end as a single unpaired tube.

The *Excretory system* consists of a very short Y-shaped vesicle opening at the extreme posterior end, with two fine ciliated tubes given off from the anterior limbs of the Y. In the female also it has a similar form. The genital opening is placed about 0.125 mm. behind the ventral sucker, about midway between the middle line and the lateral border. The cirrus sac is moderately developed and completely encloses the vesicula seminalis, which is elongated pear-shaped. Comparatively large prostate cells lie in the parenchyma of the cirrus sac. The testes begin 0.2 mm. behind the genital opening and extend backwards throughout the second quarter of the body length, consisting of eighteen to twenty rounded follicles, which lie symmetrically placed, one behind the other, midway between the intestinal limbs.

In the *female* the anterior part of the body has a very even diameter (0.058 mm.) throughout its length, while the posterior flattened part is 0.136 mm. wide. The length of the anterior part is 2.65 mm., that of the posterior 1.85 mm.

The mouth opening is ventral, a little (0.03 mm.) behind the anterior end, and there is no oral sucker. The ventral sucker is, however, well developed (fig. 22), and stalked as

in the male. It measures 0.035 mm. in diameter. The oesophagus is 0.2 mm. long, and divides into two intestinal limbs just in front of the ventral sucker. The paired limbs are very narrow and even, without diverticula, running straight through the anterior part of the body. At the junction of the anterior and posterior regions they fuse to form a single much wider tube which runs straight backwards as a single tube to the posterior end, lying in the middle of the body, surrounded on all sides by the yolk glands.

The ovary, measured in a straight line from its anterior to its posterior end is 0.388 mm. long, but, as it is thrown into a number of curves or waves along its whole course its real length is much greater than this. The oviduct runs forwards, placed nearly in the middle of the body; towards its anterior end it widens into a uterus in which was found in each case a single egg,  $0.032 \times 0.026$  mm. in size. The female genital opening lies immediately behind and to one side of the ventral sucker. The yolk glands occupy the whole field of the posterior part of the body up to the extreme posterior end and extending forwards for a length of 1.85 mm.

This form shows, perhaps, closer affinities with *Ornithobilharzia*<sup>(42)</sup> than with the other genera of this family. The members of that genus are found parasitic in European species of *Larus*. In the males of the two genera the external form, with the suckers is much the same: the configuration of the intestine is very similar. The position and arrangement of the testes are also fairly comparable though the follicles are much less numerous and less extensively distributed in *Austrobilharzia*. The position of the genital pore is practically the same. In the *females* the shape is somewhat similar as is also the arrangement of the ovary and the yolk glands, though the anterior thread-like part of the body is much longer in the Australian form, and the posterior broad part relatively shorter and conse-

quently the extent of the yolk glands much less; the ovary is also shorter. While the female is shorter than the male in *Ornithobilharzia*, it is longer in *Austrobilharzia*. While spines are quite absent in the Australian form, except on the ventral sucker of the male, in *Ornithobilharzia* the gynecophoral canal of the male is thickly lined with small pointed spines, and the female has the posterior flattened part of its body armed with thick spines, which only cease at the extreme posterior end.<sup>(42)</sup> In the latter, too, the vesicula seminalis lies quite outside the rudimentary cirrus sac and a prostate is absent, but in the former the cirrus sac is well developed and completely encloses the seminal vesicle, and contains well developed prostate cells lying in its parenchyma (fig. 21).

The structural relations between the five genera of this family may be seen at a glance in the following table:—

	Bilharzia.	Bilharziella.	Austro- bilharzia.	Ornitho- bilharzia.	Giganto- bilharzia.
Comparative size of male and female	female longer than male	female shorter than male	female longer than male	female shorter than male	female shorter than male
Suckers	present	present or absent	two in male one in female	present	absent
Spines	numerous in both male and female	only on suckers	only on ventral sucker of male	numerous in both male and female	absent
Genital pore of female	immediately behind the ventral sucker	far behind the ventral sucker	close behind the ventral sucker	behind ventral sucker	near anterior end
Testes	few	numerous	not numerous, occupy small field	numerous follicles	very numerous reaching posterior end
Cirrus sac	absent	well developed but not enclosing vesicula seminalis	well developed and enclosing vesicula seminalis	rudimentary	poorly developed
Prostate	absent	present	present	absent	absent
Eggs in uterus	numerous	one	one	one	one?



Family **MONOSTOMIDÆ.**

CYCLOCÆLUM TAXORCHIS, sp. n. (Fig. 23.)

*Diagnosis.*—Middle sized worms, widest a little behind the middle, gradually narrowed towards the anterior end, and widely rounded behind. Pharynx small, *œsophagus long*. Genital pore at posterior end of pharynx. Cirrus sac long, *reaching the intestinal limbs*. Testes side by side, one on either side of the middle line, equal in size. Fields of the yolk-glands *extend forwards as far as the pharynx*, separated in the posterior end by a distinct interval. Coils of the uterus only in one or two exceptional cases reach beyond the inner edge of the intestinal limbs.

*Host.*—*Limosa novæ-hollandiæ*, in the body cavity.

Type specimen in the Australian Museum, Sydney, No. W. 444.

Ten specimens of this species were obtained from the body cavity of the Godwit, *Limosa novæ-hollandiæ*, by Dr. Harvey Johnston, at Lord Howe Island. They are moderate in size, varying from 8 to 14 mm. in length, and 2·28 to 3·53 mm. in breadth. The cuticle is raised up into a number of prominent ridges arranged in the form of a network, so that a section near and parallel to the surface has the appearance shown in fig. 23*a*. The body is flat dorsoventrally, widest a little behind the middle, gradually reduced to a blunt rounded point at the anterior end, while the posterior extremity ends in a broad, round sweep.

The mouth opening is terminal; the oral cavity funnel-shaped; and the pharynx small 0·25 mm. long by 0·192 mm. broad. The *œsophagus* is comparatively long, 0·6 mm. The intestinal limbs pass back in a somewhat wavy course parallel to the lateral and posterior edges of the body. The excretory vesicle, almost at the pore, divides into two widely separated branches.

The genital pore is on a level with the posterior end of the pharynx. The cirrus sac, of narrow and tubular form, almost entirely filled by the coiled vesicula seminalis, lies in front of the intestinal fork, sometimes crossing the anterior edge of the latter with its posterior end. The testes are of large size, irregular in shape, and situated side by side at the same level, one on either side of the middle line. They are equal in size,  $1.36 \times 0.97$  mm. The ovary is on the right side just in front of the middle of the right testis. It is spherical in form, 0.446 mm. in diameter. The "shell-gland" is large, situated on the postero-median aspect of the ovary.

The yolk glands, consisting of comparatively large, very numerous oval follicles,  $0.059 \times 0.064$  to  $0.08 \times 0.064$  mm., extend from the posterior end of the pharynx to a level behind the intestine in the posterior end of the body. In some of the individuals the yolk glands extend further forward on one side than the other. They are confined to the lateral fields of the body, lying entirely between the intestine and the sides of the body, and are separated at the posterior end by a distinct interval. The uterus is very long and voluminous, and is arranged in a number of loops in the way that seems to be characteristic of *Cyclocoelum*; the loops for the most part lie between the middle line of the body and the lateral edges, only a few running right across the body. They do not anywhere pass out beyond the intestinal limbs, nor backward behind the testes.

The eggs are large and oval and show the characteristic increase in size as one proceeds along the uterus from the ovary. Each egg contains a miracidium with a pair of black eye-spots fused together. The eggs which are very thin-walled, vary in size from  $0.117 \times 0.059$  to  $0.139 \times 0.059$  mm.

*Cyclocoelum taxorchis* differs from all the other species of the genus in the arrangement of the testes side by side on either side of the middle line. From each of the species separately it shows a number of characteristic differences, and appears to be most closely related to *C. brasilianum*<sup>(23)</sup> which is parasitic in the South American bird *Totanus flavipes*, a bird closely related to *Limosa novæ-hollandiæ*, the host of the Australian fluke under consideration. The latter resembles *Cyclocoelum brasilianum*, and differs from the other species in its small pharynx and long œsophagus and in the forward extension of its yolk gland fields.

It differs from it, however, in the cirrus sac reaching the intestine, which it always fails to do in *C. brasilianum*; in the testes being equal in size while they are unequal in the Brazilian form and in the very characteristic arrangement of the testes.

HÆMATOTREPHUS ADELPHUS, sp. n. (Fig. 24.)

*Diagnosis*.—Moderate sized worms, 8 – 14 mm. long, pointed at the anterior end, rounded at the posterior, with the maximum breadth near the posterior end. Mouth cavity crescentic in transverse section. Œsophagus wanting. Intestinal limbs *half way between* middle line and lateral edge of the body. Genital pore at the posterior end of the pharynx. Cirrus sac projecting a little behind the intestinal fork. Yolk glands confined to the lateral fields, but meeting in the posterior end of the body. Mature eggs *very large*,  $0.24 \times 0.107$  mm.

*Host*.—*Himantopus leucocephalus*, in the body cavity.

Type specimen in the Australian Museum, Sydney, No. W. 445.

Twelve specimens of this species were obtained from the body cavity of the White-headed Stilt, *Himantopus leucocephalus*, in South Australia, by Dr. J. Burton Cleland of

the Government Bureau of Microbiology, Sydney. They are moderate sized worms, elongated and flattened, varying in length from 8.1 to 14.82 mm. and in breadth from 2.4 to 3.7 mm. They reach the maximum breadth some distance behind the middle of the body and become gradually narrower towards the anterior end which is pointed; and bluntly rounded off at the posterior end, which is almost semi-circular. Figure 24 is drawn from a specimen which does not show the characteristic shape very well, as it had undergone a good deal of contraction along the long axis and bulging in the transverse in its preservation. But at the time the drawing was made I had only two specimens available for study, and this one exhibited the various structures in the body more clearly than the other.

The mouth opening is terminal; the mouth cavity or rudimentary oral sucker is funnel-shaped and there is practically no prepharynx. The mouth cavity has the characteristic crescentic form in transverse sections owing to the prominence that occurs on its dorsal wall. But the pharynx is strongly muscular and measures  $0.35 \times 0.31$  mm. An oesophagus is practically absent, the forking of the intestine proceeding directly from the posterior end of the pharynx. The intestinal limbs, which are without cæca of any kind, lie some distance from the lateral edges of the body and practically parallel to them.

The genital pore is in the middle line, immediately at the posterior end of the pharynx. The cirrus sac is small and club-shaped and projects a little way behind the intestinal fork.

The testes are very large, irregularly oval in shape and lie obliquely, one in front of the other, in the bay of the posterior commissural circuit of the intestine. The posterior is larger, measuring  $1.07 \times 0.58$  mm., while the anterior measures  $0.93 \times 0.427$  mm.



The ovary, which lies in the middle line on a level immediately in front of the anterior testis, is oval in shape and  $0.388 \times 0.291$  mm. in size. A large "shell-gland" lies behind and to one side of the ovary. The yolk glands are confined to the field outside the intestinal limbs. Anteriorly they extend to the base of the pharynx and posteriorly the two lateral fields become continuous with one another behind the posterior commissural loop of the intestine. They are composed of small oval follicles about  $0.08 \times 0.053$  mm. The uterus is very voluminous and is arranged in numerous transverse loops, many of which stretch right across the body, whilst others only reach from the middle line to the lateral edge. These loops are not directly transverse, but have the backward inclination which seems to be characteristic of the genus, the angle of inclination becoming more marked as we proceed backwards, till at the posterior end the last couple of loops on each side proceed almost directly backwards on either side of the testes, almost reaching the posterior end of the body. The proximal portion is dilated to form a receptaculum seminis uterinum and is filled with sperms. The eggs are very thin-shelled, elliptical, and show an increase in size as one follows the uterus towards the anterior end. The eggs in the end near the ovary measure  $0.187 \times 0.107$  mm.; in the distal part, however,  $0.241 \times 0.107$  mm. Each of the eggs contains a miracidium with a conjoined pair of dark pigmented eye-spots.

This species is very similar in structure to *H. similis*, Stossich, parasitic in the abdominal cavity of *Himantopus atropterus*, and to *H. consimilis*, Nicoll, parasitic in the thoracic cavity of the Spur-winged Plover *Lobivanellus lobatus*. Besides the differences in host and a number of minor structural differences, such as the extension and the position of the yolk-glands, it differs from the two named in having considerably larger eggs, which when mature

reach a size of  $0.241 \times 0.107$  mm., while those of *H. consimilis*, Nicoll, <sup>(39, p. 125)</sup> do not exceed  $0.2 \times 0.08$  mm., and those of *H. similis*, Stoss.,  $0.202 \times 0.083$  mm. (Dietz, <sup>13, p. 527</sup>).

HYPTIASMUS MAGNUS, sp. n. (Fig. 25.)

*Diagnosis*.—Large worms, with an elongated, flattened body, widest towards the posterior end. Intestinal limbs separated from the lateral edges of the body by a *wide interval*. Half the cirrus sac lying *behind* the fork of the intestine. Testes *very large*. Three gonads close together. Lateral fields of the yolk glands *not continuous with one another* behind the commissural part of the intestinal limbs. Loops of the uterus *not extending back* behind the anterior border of the posterior testis.

*Host*.—*Chenopsis atrata*, in the pharynx.

Type specimen in the Australian Museum, Sydney, No. W. 446.

Two specimens of this large fluke were obtained from the pharynx of the Black Swan, *Chenopsis atrata*, in Victoria, by Mr. A. Le Souef, Director of the Zoological Gardens at Sydney. The length of these specimens is 19 mm., and the breadth 4.5 mm. at the widest part in the region of the anterior testis. It tapers fairly gradually to a blunt point in front, but is rounded behind. The integument is made rough by a number of transverse ridges of thickened cuticle that cross the body transversely. The mouth cavity is funnel-shaped, 0.388 mm. long. Between this and the pharynx is interposed a distinct prepharynx 0.29 mm. long. The pharynx is 0.349 mm., and the oesophagus 0.582 mm. long. The large cerebral ganglia lie at the anterior end of the prepharynx, just at its junction with the mouth cavity. The intestinal limbs which are wide, run about halfway between the middle line of the body and the lateral edges, bending inwards a little between the testes.

The genital pore is very far forward, right in front of the pharynx, in the middle line, ventral to the prepharynx. In figure 25 it is shown as lying just to the side of the prepharynx which has become a little displaced to the right in the specimen from which the drawing was made, through pressure. The cirrus sac which is almost completely filled up by the vesicula seminalis is somewhat pear-shaped, with the anterior end elongated. Posteriorly it reaches a level some distance behind the intestinal fork.

The testes are exceedingly large, roughly rounded, with a surface irregular through shallow indentations. The oval ovary, with its long axis transversely placed, lies between them but nearer the posterior, several loops of the uterus intervening between it and the anterior testis. The three gonads are placed in a straight line slightly inclined to the longitudinal axis of the body. The anterior testis,  $1.96 \times 1.76$  mm., is somewhat smaller than the posterior,  $2.28 \times 1.96$  mm., while the ovary,  $0.97 \times 0.776$  mm., is a good deal smaller than either.

The yolk glands are mainly on the outer sides of the intestinal limbs, spreading very little on their dorsal and ventral surfaces. In front they do not reach the level of the intestinal fork, and behind are separated by a wide interval. The follicles are oval in shape and fairly variable in size, from  $0.054 - 0.133$  mm. long, by  $0.043 \times 0.085$  mm. wide.

The uterus is exceedingly long and voluminous, and the loops run for the most part right across the body, reaching well into the lateral fields between the intestinal limbs and the lateral edges, but some of the loops run from the sides to the middle line only, as in *Cyclocœlum*. None of the loops pass further back than the anterior border of the posterior testis.

The eggs, which are very thin shelled, increase very considerably in size during their passage along the uterus. In the proximal parts, near the ovary, they measure  $0.075 \times 0.04$  mm.; about the middle they vary from  $0.081 \times 0.043$  to  $0.091 \times 0.053$  mm.; and in the distal portion, towards the opening, they attain the size of  $0.112 \times 0.059$  mm.

This species is closely related to a group of species *H. arcuatus*, *H. lævigatus*, and *H. tumidus*, all parasitic in various anseriform birds in Europe. Besides a number of minor points, such as the size and shape of the body and the position of the intestine in regard to the sides and posterior end of the body, it differs from all of these in the cirrus sac projecting back much further behind the intestinal fork; in the much larger testes, and in having the gonads much closer together; and in having the lateral fields of the yolk glands separated from one another at the posterior end. In the three European species some loops of the uterus pass as far back as the hinder border of the posterior testis or beyond it, while in the Australian form they do not pass further back than the anterior border.

## PART II.

List of the trematode parasites of Australian birds, together with closely related forms.

### OPISTHORCHINÆ.

*Opisthorchis obsequens*, Nicoll, obtained from the liver of *Hieracidea berigora* in Queensland, is related to *O. interruptus*, Brn., found in the South American bird *Alcedo viridirufa*.

### PSILOSTOMINÆ.

*Orchipedium sufflavum*, Nicoll, parasitic in the œsophagus of the Black Spoonbill *Platalea regia*, in Australia, seems to find its nearest relative in *Orchipedium tracheicola* Brn., parasitic in the European *Anas fusca*.



## COENOGONIMINÆ.

*Scaphanocephalus australis*, sp. n., from the intestine of the Sea Eagle *Haliaetus leucogaster*, is closely related to *S. expansus*, Jägerskiöld, parasitic in the Sea Eagle *Pandion haliaetus* from the Red Sea.

## ECHINOSTOMINÆ.

Including those described in this paper, seventeen members of this group are recorded from Australian birds. Three of these are represented by the same species in European or Asiatic birds, while the others are all more or less closely related to other species of the same family occurring in similar birds in other parts of the world.

*Echinostoma acuticauda*, Nicoll, parasitic in the Straw-necked Ibis, *Carphibis spinicollis*, in Queensland, is related to *E. revolutum*, found in European Anseriformes, and to *E. mendax*, Dietz, parasitic in certain South American birds belonging to the same family; while *E. revolutum* itself is found in certain Australian Anseriformes.

The related forms *E. elongatum*, Nicoll, and *E. emollitum*, Nicoll, parasitic in *Podargus strigoides* and *Centropus phasianus* respectively, may be looked upon as Australian representatives of *E. uncatum*, Dietz, found in two species of *Crotophaga* in Brazil. *E. hilliferum*, Nicoll, from *Porphyrio melanotus* (Rallidæ), and *E. australasianum*, Nicoll from *Antigone australasiana* (Gruidæ) are related to *E. sarcinum*, Dietz, parasitic in the European *Grus Grus*.

*Echinochasmus prosthovitelatus*, Nicoll, parasitic in the intestine of the Brown Hawk, *Hieracidea orientalis*, in Queensland, is related to *Echinochasmus euryporus*, Lss., found in several species of hawks belonging to the genus *Milvus* in Egypt. *E. tenuicollis*, sp. n. from the intestine of the shag, *Phalacrocorax melanoleucus* finds its nearest relative in *E. coaxatus*, Dtz., which is also parasitic in a water bird, *Podiceps cristatus*.

*Himasthla harrisoni*, sp. n. from *Numenius cyanopus* is closely related to *H. rhigedana*, Dtz., parasitic in two species of *Numenius* that inhabit the Sinai peninsula on the Red Sea.

*Acanthoparyphium spinulosum*, sp. n. from the duodenum of *Charadrius dominicus* seems to be most closely related to *A. phœnicopteri*, Lhe., parasitic in the African *Phœnicopterus roseus*.

*Echinoparyphium oxyurum* and *E. harveyanum* found in *Herodias timoriensis* and *Micraeca fascians* respectively are related to *E. elegans*. Lss., *E. aconiatum*, Dtz., and *E. agnatum*, Dtz., found in *Buteo* and *Vanellus*.

*Patagifer bilobus*, Rud., which occurs in the intestine of several European and South American Ardeiformes is also found in Australia in a number of birds of the same family. *P. acuminatus* and *P. fraternus* are Australian species closely related to the foregoing and found in similar birds, e.g., *Ibis molucca* and *Herodias timoriensis* respectively.

*Chaunocephalus ferox*, is another Echinostomid having, like *Patagifer bilobus*, a very wide distribution. It is found in Australia in the Black-necked Stork, *Xenorhynchus asiaticus*, a bird which occurs in India, Burmah, the Malay Peninsula, New Guinea, and Northern Australia. The same trematode is also recorded from several species of storks in Europe.

#### PLAGIORCHINÆ.

*Plagiorchis* (*Lepoderma*) *nisbetii*, Nicoll, from *Chibia* (*Dicrura*) *bracteata* is related to *P. cirratum*, Rud., found in *Corvus monedula* in Europe; and *P. clelandi* from *Petrochelidon ariel* in Australia is closely related to *P. maculosus* parasitic in the European swallow *Hirundo*. All these hosts are passeriform birds. *P. spatulatus*, another Australian form, is also fairly close to *P. maculosus*, but it occurs in one of the Motacillidæ, *Anthus australis*.

## MICROPHALLINÆ.

*Levinseniella howensis*, from the cæcum of *Charadrius dominicus*, finds its nearest relative in *L. brachysoma*, Jägers., which is parasitic in a Scandinavian species of *Charadrius*.

## CEPHALOGONIMINÆ.

*Prosthogonimus vitellatus*, Nicoll, found in *Chibia bracteata* is closely related to *P. cuneatus* found in several European Passeriformes.

## DICROCOELIINÆ.

*Platynotrema biliosum*, Nicoll, and *P. jecoris*, Nicoll, two closely related members of this sub-family are found in the liver of the same species of host, the Stone Curlew, *Burhinus grallarius*, and are related most nearly, perhaps to *Dicrocoelium illiciens*, Brd., which occurs in several Brazilian birds, e.g., *Rhamphastus* sp., and *Pipra* sp.

*Lyperosomum parvum*, sp. n., parasitic in one of the Corvidæ, *Strepera versicolor*, is evidently very closely related to an unnamed species of *Lyperosomum* in von Linstow's collection, figured by Braun (Pl. x, fig. 66), which was obtained from the intestine of *Corvus corone*. Two other species, *L. megastomum* and *L. harrisoni* which are probably related to *L. parvum* are found in birds not belonging to the Corvidæ.

## HARMOSTOMINÆ.

*Harmostomum pulchellum* from the Wonga Pigeon, *Leucosarcia picata* is related to *H. mordens*, Brn., which is found in *Rallus* sp., birds fairly closely related to the Columbiformes to which the Wonga Pigeon belongs.

## CLINOSTOMINÆ.

*Clinostomum australiense*, sp. n. from the oesophagus of *Plotus novæ-hollandiæ* is closely related to *C. marginatum* found in various species of *Ardea* in America; while *C.*

*hornum*, Nicoll, found in the trachea and œsophagus of the Nankeen Heron, *Nycticorax caledonicus* is also related to *C. marginatum* and to *C. complanatum*, Rud., parasitic in the European Heron, *Ardea cinerea*.

#### BILHARZIIDÆ.

*Austrobilharzia terrigalensis* parasitic in the sea-gull, *Larus novæ-hollandiæ* finds its nearest relative in *Ornithobilharzia intermedia*, parasitic in various European species of *Larus*.

#### MONOSTOMIDÆ.

*Cyclocoelum taxorchis*, from the body cavity of *Limosa novæ-hollandiæ* is closely related to *C. brasilianum* parasitic in *Totanus flavipes*. *Totanus* and *Limosa* are closely related bird-genera.

*Hæmatotrephus consimilis*, Nicoll, found in the Spur-winged Plover, *Lobivanellus lobatus* and *H. adelphus* sp. n. parasitic in *Himantopus leucocephalus* are both closely related to *H. similis*, Stossich, found in the abdominal cavity of *Himantopus atropterus* in Egypt. All these birds are members of the family Charadriidæ. *Typhlocoelum reticulare*, mihi, parasitic in *Anseranas semipalmatus* is the Australian representative of *T. cucumerinum*, Rud., found in various species of *Anas* in Europe. *Allopyge antigones*, mihi, parasitic in the great Australian Crane, *Antigone australasiana* is closely related to *Hyptiasmus ominosus*, Stoss. and *H. adolphi*, Stoss., found in several species of European Cranes. *Hyptiasmus magnus*, found in the pharynx of the Black Swan, *Chenopsis atrata* is closely related to *H. arcuatus*, *H. laevigatus* and *H. tumidus* all parasitic in various Anseriform birds in Europe.

*Notocotylus attenuatus*, Rud., common in European ducks and geese has also been recorded from a considerable number of related birds in Australia.



## HOLOSTOMIDÆ.

*Strigea promiscua*, Nicoll, found in the intestine of two owls in Queensland, *Ninox maculata* and *N. boobook* is nearly related to *S. gracilis*, which occurs in certain anseriformes in Europe. *Strigea flosculus*, Nicoll is a worm of doubtful affinities.

*Hemistomum brachyurum*, Nicoll, found in the intestine of *Ninox maculata* in Queensland, and *Hem. triangulare mihi*, parasitic in *Dacelo gigas* and *Ninox maculata* in New South Wales may be looked upon as the Australian representatives of the European *Hem. spathula* parasitic, in various members of the Strigiformes.

*Hemistomum intermedium*, mihi, found in the duodenum of the Black Swan, *Chenopsis atrata*, seems to be a connecting link between *Hemistomum* and *Holostomum*. It does not appear to have any near relatives and it must be looked upon as an aberrant or perhaps rather a primitive form.

*Holostomum hillii*, mihi, found in the duodenum of *Larus novæ-hollandiæ* is nearly related to *H. erraticum* which is found parasitic in several species of *Larus* in Europe. *Holostomum simplex*, mihi, from the intestine of *Ardea novæ-hollandiæ* is more nearly related to *H. cornu* than to any other form. *H. cornu* is parasitic in various old-world species of herons belonging to the genus *Ardea*.

*Holostomum musculosum* found in the duodenum of the Crested Tern, *Sterna bergii*, is most nearly related perhaps to *H. bursigerum* found parasitic in several European Lariiformes.

List of the Trematode Parasites of Australian birds, arranged according to the classification of the birds, together with the nearest relative of the trematode and its host, so that the relationships of the hosts may come into view.

Australian Bird.	Trematode Parasite.	Nearest Relative.	Host of Latter.
Order COLUMBIFORMES <i>Leucosarcia picata</i>	<i>Harmostomum pulchellum</i>	<i>H. mordens</i>	<i>Rallus</i> sp.
Order RALLIFORMES <i>Porphyrio melanotus</i>	<i>Echinostomum hilliferum</i>	<i>E. sarsinum</i>	<i>Grus grus</i>
Order LARIFORMES <i>Sterna bergii</i>	<i>Lyperosomum megastomum</i>	?	
	<i>Holostomum musculosum</i>	<i>H. bursigerum</i>	Lariformes in Europe
<i>Larus novæ-hollandiæ</i>	<i>Austrobilharzia terrigalensis</i>	<i>Ornithobilharzia intermedia</i>	<i>Larus fuscus</i>
	<i>Holostomum hillii</i>	<i>Hol. eraticum</i>	<i>Larus</i> spp.
Order CHARADRIFORMES <i>Lobivanellus lobatus</i>	<i>Hæmatotrephus consimilis</i>	<i>H. similis</i>	<i>Himantopus atropterus</i>
	<i>Echinostomum ignavum</i>	?	
<i>Charadrius dominicus</i>	<i>Acanthoparyphium spinulosum</i>	<i>A. phænicopteri</i>	<i>Phænicopterus roseus</i>
	<i>Levenseniella howensis</i>	<i>L. brachysoma</i>	<i>Charadrius hiaticula</i> in Scandinavia
<i>Himantopus leucocephalus</i>	<i>Hæmatotrephus adelphus</i>	<i>H. similis</i>	<i>Himantopus atropterus</i>
<i>Numenius cyanopus</i>	<i>Himasthla harrisoni</i>	<i>H. rhigedana</i>	<i>Numenius arabicus</i> and <i>N. arquatus</i>
<i>Limosa novæ-hollandiæ</i>	<i>Cyclocoelum tazorchis</i>	<i>C. brasilianum</i>	<i>Tolanus flavipes</i> (Charadriiformes)
<i>Burhinus grallarius</i>	<i>Platynotrema biliosum</i>	<i>Dicrocælium illiciens</i>	<i>Pipra</i> (passeriform)
	<i>P. jecoris</i>		
Order GRUIFORMES <i>Antigone australasiana</i>	<i>Allopyge antigones</i>	<i>Hyptiasmus ominosus</i> and <i>H. adolphi</i>	in European Gruiformes
	<i>Echinostomum australasianum</i>	<i>E. sarcinum</i>	in European <i>Grus grus</i>
Order ARDEIFORMES <i>Ibis molucca</i>	<i>Patagifer acuminatus</i>	<i>P. bilobus</i>	several Ardeiformes in Europe
<i>Carphibis spinicollis</i>	<i>Echinostoma acuticauda</i>	<i>E. mendax</i>	Anseriformes
<i>Platalea regia</i>	<i>Orchipedum sufflavum</i>	<i>O. tracheicola</i>	<i>Anas fusca</i>
	<i>Patagifer bilobus</i>	Same species in Europe	<i>Platalea leucorodia</i>
<i>Pelegadis falcinellus</i>	" "	" "	" "
<i>Xenorhynchus asiaticus</i>	<i>Chaunocephalus ferox</i>	Same species occurs in other parts.	in Ardeiformes in
<i>Herodrias timoriensis</i>	<i>Patagifer fraternus</i>	<i>P. bilobus</i>	several Ardeiformes in other regions
	<i>Echinoparyphium oxyurum</i>	<i>E. aconiatum</i>	<i>Vanellus vanellus</i>

## LIST OF THE TREMATODE PARASITES—continued.

Australian Bird.	Trematode Parasite.	Nearest Relative.	Host of Latter.
<i>Ardea novæ-hollandiæ</i>	<i>Holostomum simplex</i>	<i>H. cornu</i>	<i>Ardea</i> sp.
<i>Nycticorax caledonicus</i>	<i>Clinostomum</i> <i>hornum</i>	<i>C. marginatum</i> and <i>C. complanatum</i>	<i>Ardea cinerea</i> in Europe, etc.
Order ANSERIFORMES			
<i>Chenopsis atrata</i>	<i>Hemistomum</i> <i>intermedium</i>	?	
	<i>Hyptiasmus magnus</i>	<i>H. arcuatus</i> and <i>H. laevigatus</i>	European Anseri- formes
<i>Anseranas semipalmata</i>	<i>Typhlocoelum</i> <i>reticulare</i>	<i>T. cucumerinum</i>	<i>Anas</i> spp. in Europe
<i>Anas superciliosa</i>	<i>Echinostomum</i> <i>revolutum</i>	Same species in Europe	<i>Anas boschas</i> and other species of Anseriformes
<i>Nettopus pulchellus</i>	<i>Notocotylus</i> <i>attenuatus</i>	Same species	in various species of Anseriformes
<i>Anas superciliosa</i>	" "	" "	in Europe
<i>Chenopsis atrata</i>	" "	" "	
Order PELICANIFORMES			
<i>Phalacrocorax melan- oleucus</i>	<i>Dolichosaccus</i> <i>solecarius</i>	<i>D. trypherus</i>	in frogs
	<i>Echinochasmus</i> <i>tenuicollis</i>	<i>E. coaxatus</i>	<i>Podiceps cristatus</i>
<i>Plotus novæ-hollandiæ</i>	<i>Clinostomum</i> <i>australiense</i>	<i>C. marginatum</i>	Ardeiformes
Ord. ACCIPITRIFORMES			
<i>Haliaetus leucogaster</i>	<i>Scaphanocephalus</i> <i>australis</i>	<i>S. expansus</i>	<i>Pandion haliaetus</i> (Accipitriformes)
<i>Hieracidea berigora</i>	<i>Opisthorchis</i> <i>obsequens</i>	<i>O. interruptus</i>	<i>Alcedo viridirufa</i> (Kingfisher)
<i>H. orientalis</i>	<i>Echinochasmus</i> <i>prosthovitelatus</i>	<i>E. euryporus</i>	<i>Milvus</i> spp. in Egypt (Accipitriformes)
Order STRIGIFORMES			
<i>Ninox boobook</i>	<i>Lyperosomum</i> <i>harrisoni</i>	<i>L. parvum</i>	<i>Strepera versicolor</i>
	<i>Strigea promiscua</i>	<i>S. gracilis</i>	Anseriformes in Europe
<i>N. maculata</i>	<i>Strigea promiscua</i> <i>Hemistomum</i> <i>brachyurum</i> <i>Hem. triangulare</i>	<i>S. gracilis</i> <i>Hem. spathula</i> " "	Anseriformes European Strigi- formes " "
Order CORACIIFORMES			
<i>Podargus strigoides</i>	<i>Echinostomum</i> <i>elongatum</i>	<i>E. uncatum</i>	<i>Crotophaga</i> spp. (Picarine Bird)
<i>Dacelo gigas</i>	<i>Hem. triangulare</i> <i>Strigea flosculus</i>	<i>Hem. spathula</i> ?	Strigiformes
Order COCCYGES			
<i>Centropus phasianus</i>	<i>Echinostomum</i> <i>emollitum</i>	<i>E. uncatum</i>	<i>Crotophaga</i> spp.
Order PASSERIFORMES			
<i>Petrochelidon ariel</i>	<i>Plagiorchis clelandi</i>	<i>P. maculosus</i>	<i>Hirundo</i> spp. (Passeriformes)
<i>Microeca fascians</i>	<i>Echinoparyphium</i> <i>harveyanum</i>	<i>E. aconiatum</i>	<i>Vanellus</i> spp. (Charadriiformes)
<i>Anthus australis</i>	<i>Plagiorchis</i> <i>spatulatus</i>	<i>P. maculosus</i>	Passeriformes in Europe
<i>Chibia bracteata</i>	<i>Plagiorchis nisbetii</i>	<i>P. cirratum</i>	<i>Corvus monedula</i> (Passeriformes)
	<i>Prosthogonimus</i> <i>vitellatus</i>	<i>P. cuneatus</i>	Several European Passeriformes
<i>Strepera versicolor</i>	<i>Lyperosomum</i> <i>parvum</i>	<i>Lyperosomum</i> sp. (of von Linstow)	<i>Corvus corone</i> in Europe

Of all the trematodes known from Australian birds only four have been referred to new genera, viz., *Platynotrema biliosum* Nicoll, *P. jecoris* Nicoll, *Allopyge antigones* mihi and *Austrobilharzia terrigalensis* mihi. The remainder have not only been referred to known genera, but are, for the most part, pretty closely related to known species occurring in other parts of the world. In some of the birds which are migratory or have a very wide range the same trematode has been recorded as occurring in them both in Australia and in Asia, Europe or other parts; for instance the Echinostomid *Chaunocephalus ferox* Rud. has been recorded both from Asia and Australia as parasitic in the Jabiru, *Xenorhynchus asiaticus*, a stork that ranges from India through Southern Asia and the East Indies to Northern Australia. *Patagifer bilobus* Rud. has been recorded several times in Australia from *Platalea regia* and *Pele-gadis falcinellus* and was originally described in Europe as a parasite of the European *Platalea leucorodia*. With one exception, all the trematodes known from Australian birds are either identical with, or more or less closely related to parasites of birds in other parts of the world.

It is a remarkable and significant fact that all these relatives of the Australian forms should find birds as their hosts. And further than this, the bird-hosts of similar forms are almost in every case birds of a similar kind.

Of the fifty-one trematodes of Australian birds mentioned in the foregoing table, thirty find their nearest relatives in trematodes parasitic in birds of the same family, ten in birds of a closely related family, and seven in birds which cannot be considered closely related to the Australian bird-hosts, while three are so constituted that they do not seem to have any near relatives amongst known trematodes.

In the case of the first group and perhaps also of the second, it may be considered that the pairs of related



trematodes have been derived from common ancestors, and also that their hosts have been derived from common ancestors, and that the ancestors of the trematodes were parasitic in those of the birds. For instance, *Holostomum hillii* and *H. eraticum*, two closely related species of *Holostomum*, are parasitic in various species of *Larus*. These sea-gulls are apparently derived from common ancestors in which the species of trematode that gave rise to *H. hillii* and *H. eraticum* was parasitic. As the original *Larus* spread over the earth till, in the course of time, it attained the present very wide distribution of the genus, by the acquisition of different characters it became split up into a number of species. Evolutionary agencies were at the same time working on the trematodes which accompanied the birds, and one group eventually became separable from another as a distinct species.

The want of relationship between the hosts in the case of the seven pairs in the third group, may be explained on the supposition that in the one case or the other the parasite has been acquired by the bird much more recently.

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## EXPLANATION OF PLATES.

The drawings which were made by Mr. W. F. Atkins of the Technical High School, Sydney, were all done with the help of the camera lucida.

## REFERENCE LETTERS.

<i>c. g.</i> Cerebral ganglion	<i>O.</i> Ovary
<i>c. s.</i> Cirrus sac.	<i>O. d.</i> Oviduct
<i>c.</i> Cirrus	<i>P.</i> Penis
<i>Ej. d.</i> Ejaculatory duct	<i>Ph.</i> Pharynx
<i>E.</i> Excretory vessel	<i>Pr.</i> Prostate
<i>Ex. p.</i> Excretory pore	<i>R. s.</i> Receptaculum seminis
<i>Ex. v.</i> Excretory vesicle	<i>R. s. u.</i> Receptaculum seminis uterinum
<i>F. C.</i> Flame cell	<i>S. g.</i> "Shell-gland"
<i>G. p.</i> Genital pore	<i>T.</i> Testis
<i>G. S.</i> Genital sinus	<i>Ut.</i> Uterus
<i>Int.</i> Intestinal limbs	<i>Vag.</i> Vagina or metraterm
<i>L. c.</i> Laurer's canal	<i>v. d.</i> Vas deferens
<i>L. t.</i> Lateral nerve-trunk	<i>v. s.</i> Vesicula seminalis
<i>M. O.</i> Mouth-opening	<i>v. sk.</i> Ventral sucker
<i>N.</i> Nervous system	<i>y. d.</i> Yolk-duct
<i>N. t.</i> Nerve trunk	<i>y. g.</i> Yolk-glands
<i>Œs.</i> Œsophagus	<i>y. r.</i> Yolk-reservoir
<i>O. S.</i> Oral Sucker	

## PLATE IX.

Fig. 1.—General view of *Scaphanocephalus australis* from a whole mount. *G. cx.* genital sucker.  $\times 45$ .

Fig. 1a.—Flame cell of *S. australis*.  $\times 350$ .

## PLATE X.

Fig. 2.—*Patagifer acuminatus*, whole mount.  $\times 12$ .

Fig. 3.—*P. acuminatus*, more enlarged drawing of the head-collar and anterior end, showing the arrangement of the collar-spines, etc.  $\times 33$ .

Fig. 4.—*Patagifer fraternus*, anterior end showing the arrangement of the collar-spines.  $\times 53$ .

## PLATE XI.

Fig. 5.—*Echinochasmus tenuicollis*, whole mount.  $\times 35$ .

Fig. 6.—*Echinoparyphium oxyurum*, whole mount.  $\times 20$ .

## PLATE XII.

Fig. 7.—*Acanthoparyphium spinulosum*, whole mount.  $\times 16$ .

Fig. 8.—*Echinoparyphium harveyanum*, whole mount.  $\times 21$ .

Fig. 9.—Anterior end of the same under higher magnification to show the arrangement of the collar-spines, the spines on the neck and the cirrus sac.  $\times 72$ .

## PLATE XIII.

Fig. 10.—*Himasthla harrisoni*, whole mount.  $\times 10$ .

Fig. 11.—*Plagiorchis spatulatus*, whole mount.  $\times 75$ .

Fig. 11a.—*Plagiorchis clelandi*, whole mount.  $\times 41$ .

## PLATE XIV.

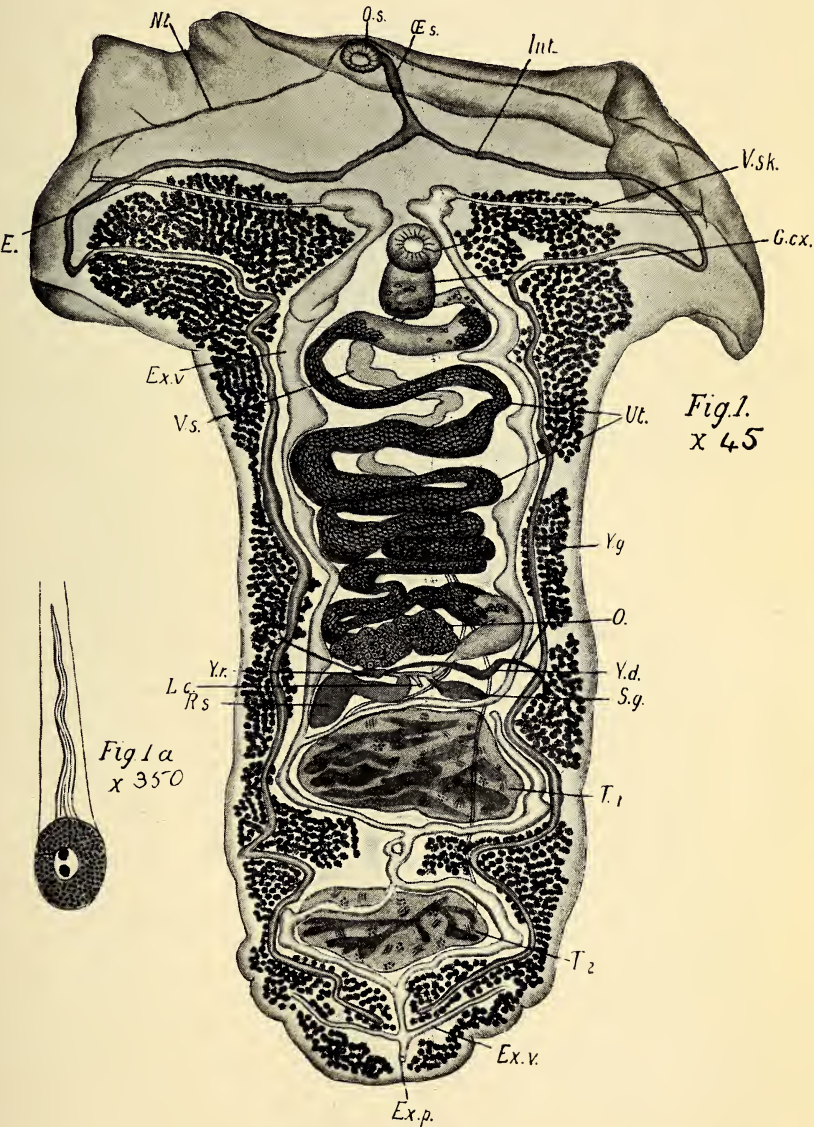
Fig. 12.—*Dolichosaccus solecarius*, whole mount.  $\times 100$ .

Fig. 13.—*Levinseniella howensis*, whole mount.  $\times 115$ .

## PLATE XV.

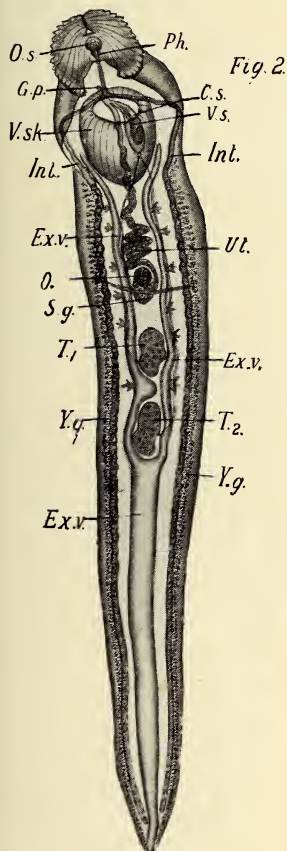
Fig. 14.—*Lyperosomum parvum*, whole mount.  $\times 50$ .

Fig. 15.—*L. megastoma*, whole mount.  $\times 44$ .

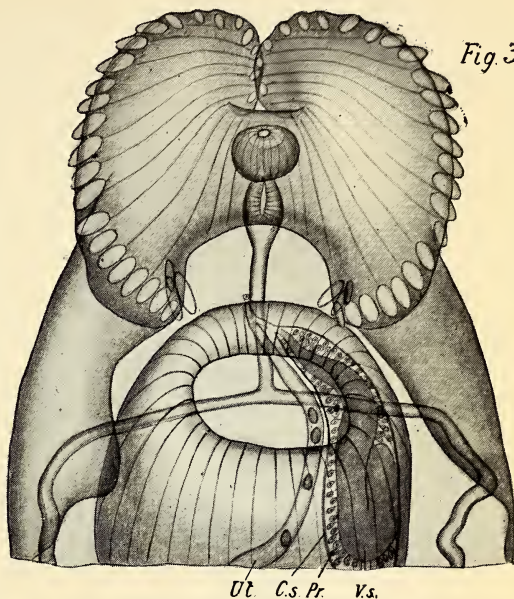


*Scaphanocephalus*  
*australis.*

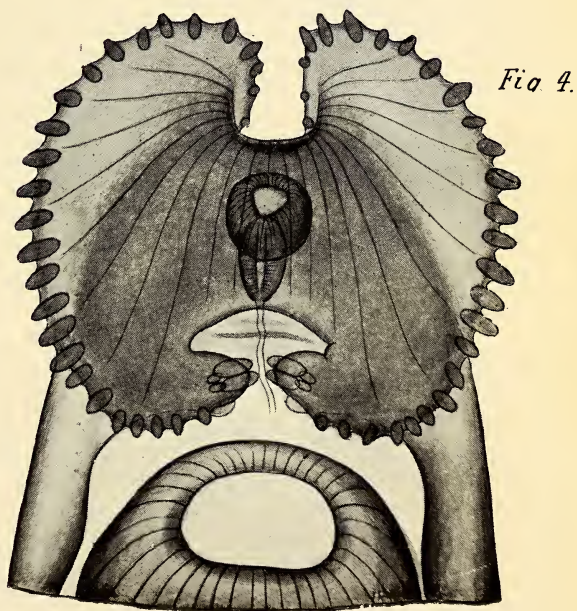




*Patagifer acuminatus.*

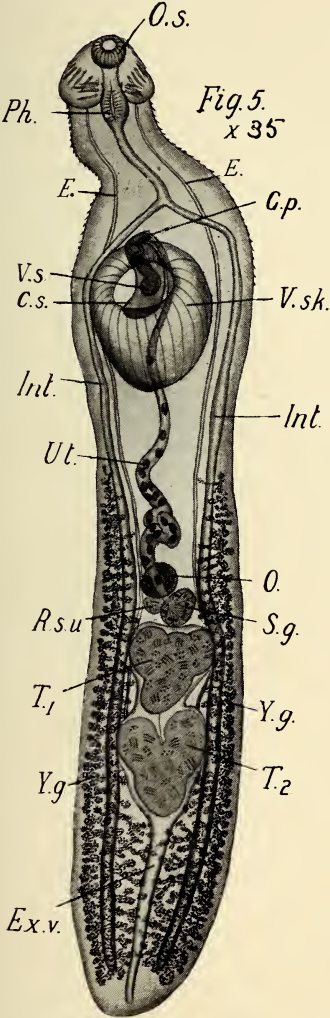


*Patagifer acuminatus*

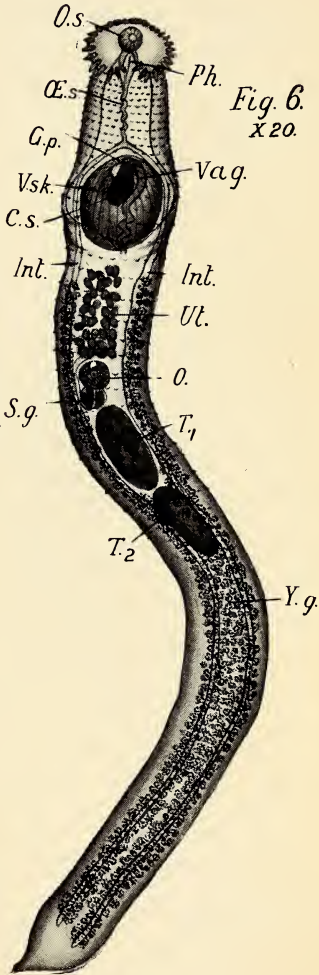


*Patagifer fraternus*

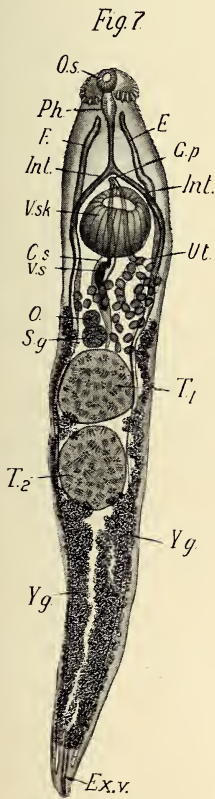




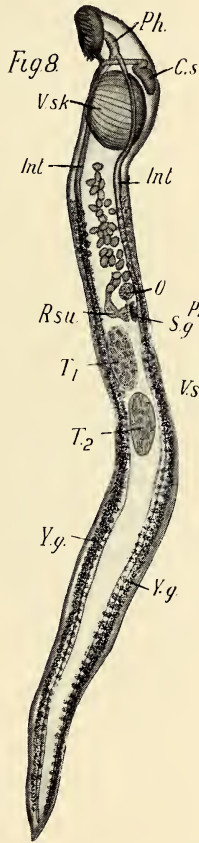
*Echinochasmus tenuicollis*.



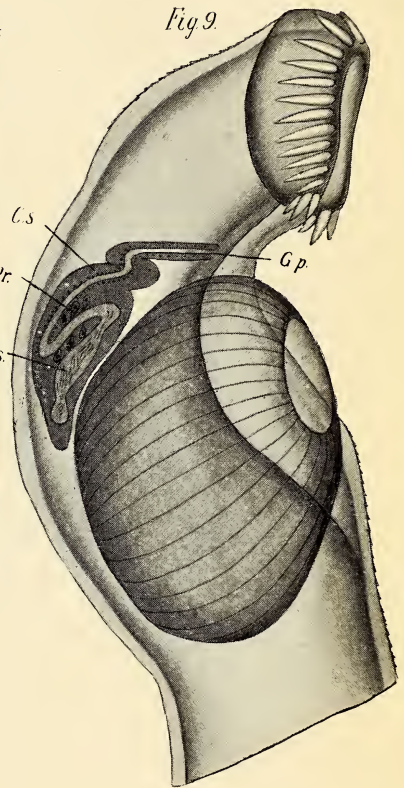
*Echinoparyphium oxyurum*.

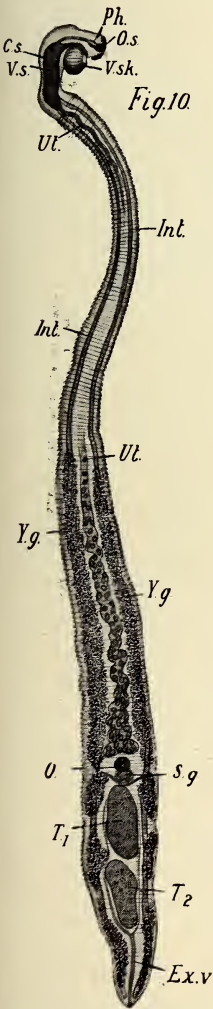


*Acanthoparyphium spinulosum.*

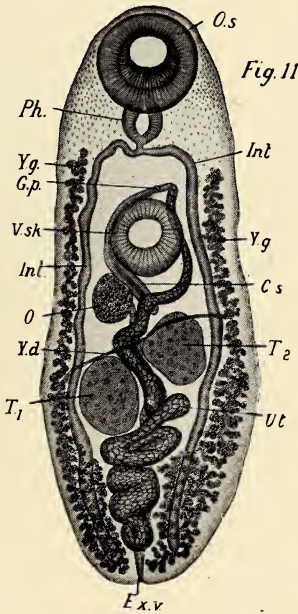


*Echinoparyphium harveyanum.*

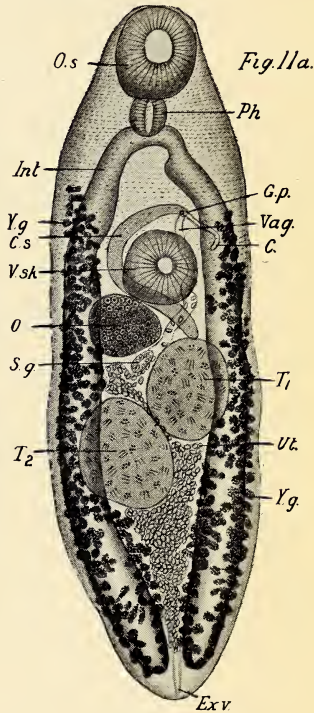




*Himasthla harrisoni*

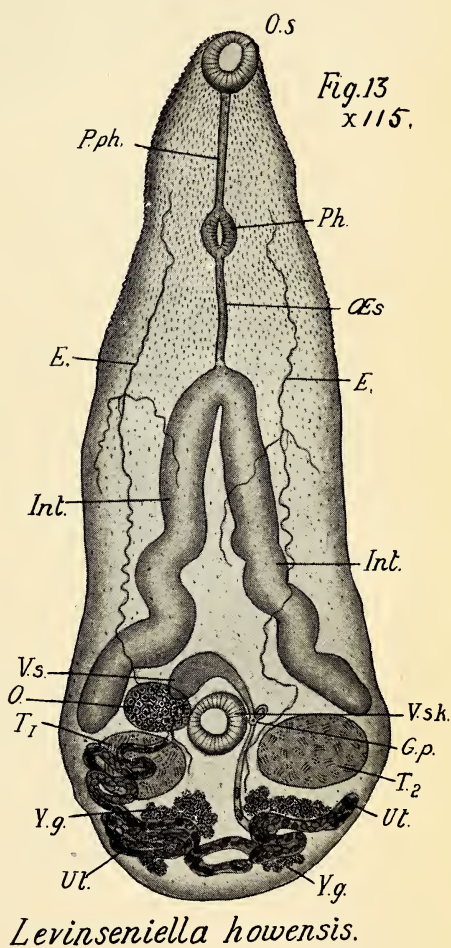
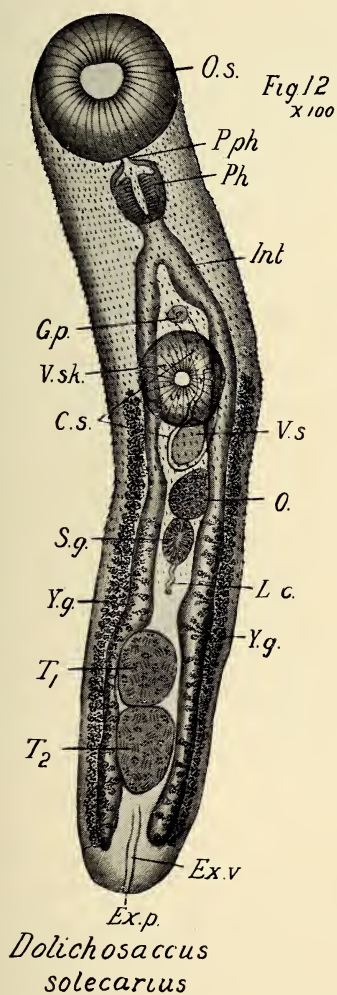


*Plagiorchis spatulatus*

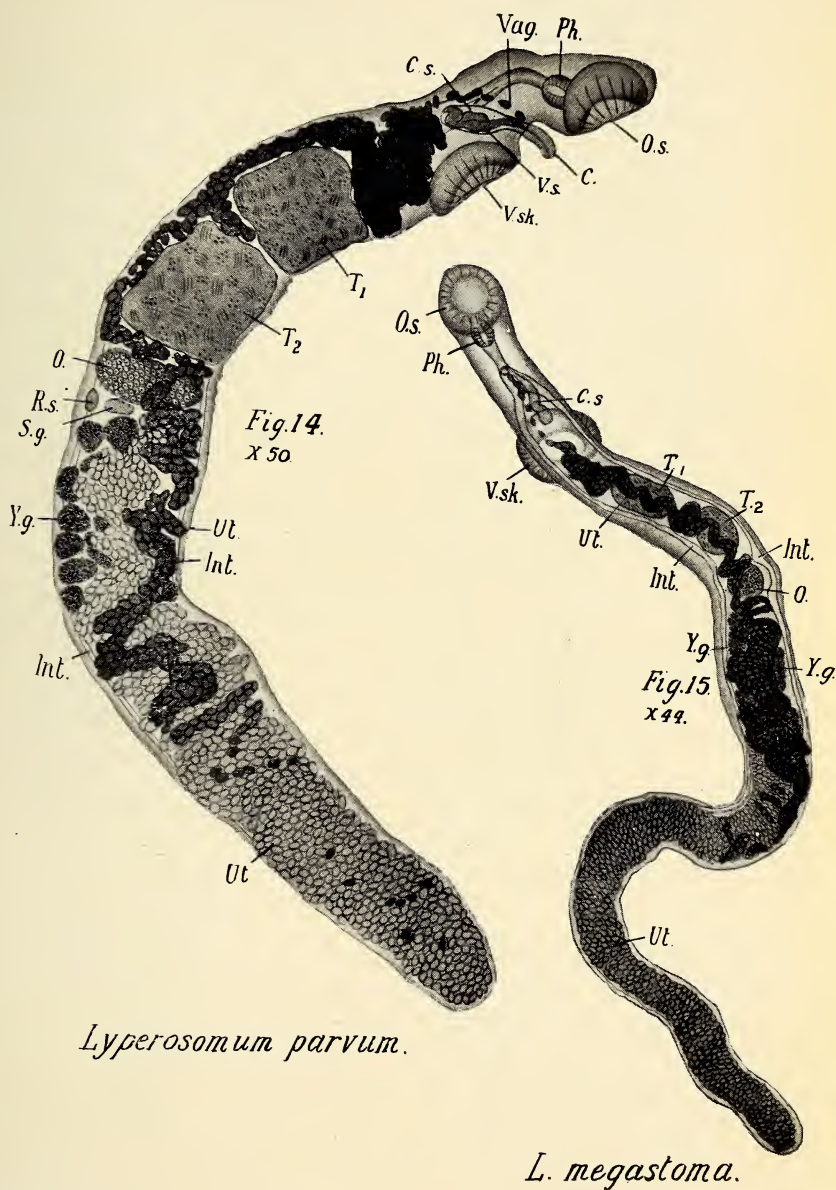


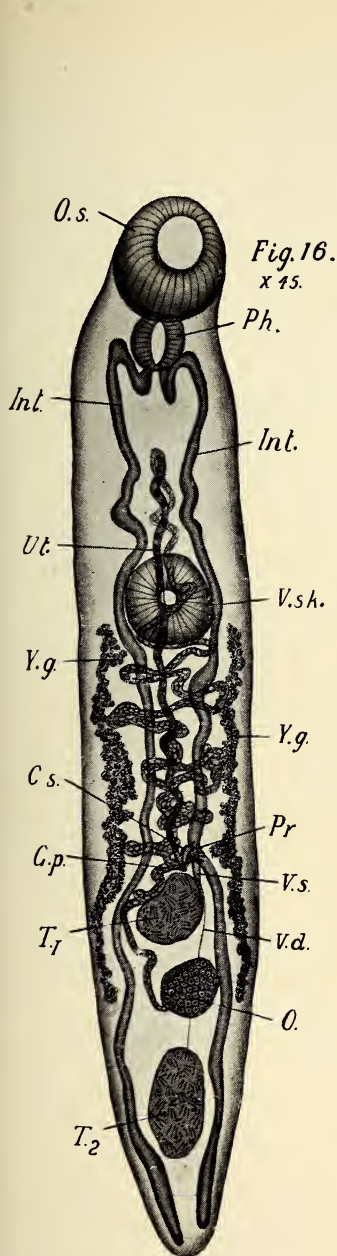
*Plagiorchis celandi.*



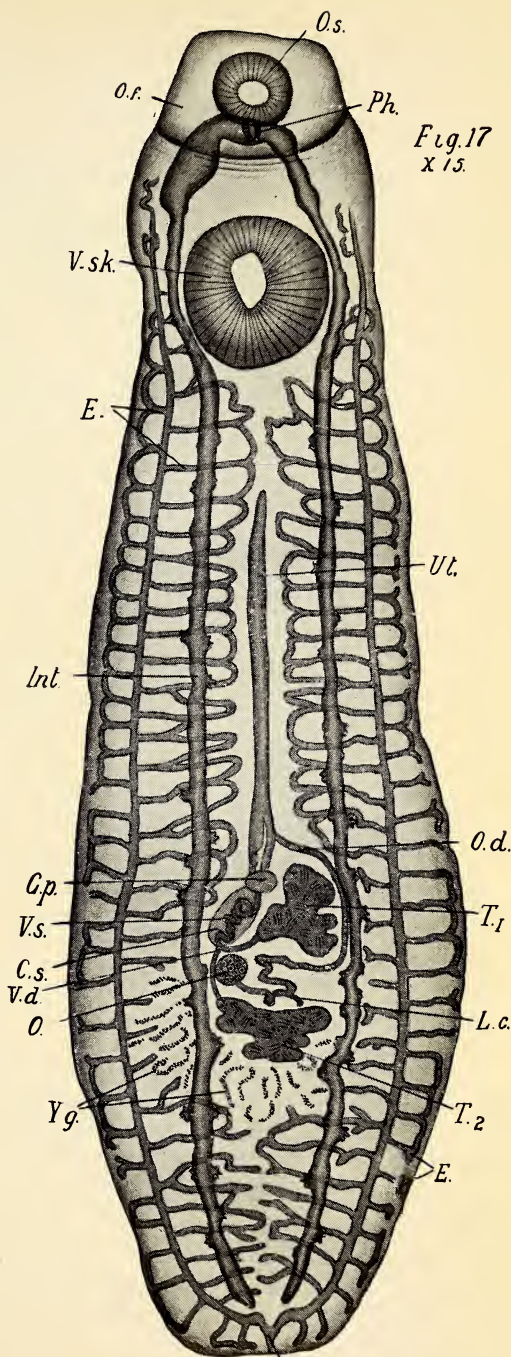




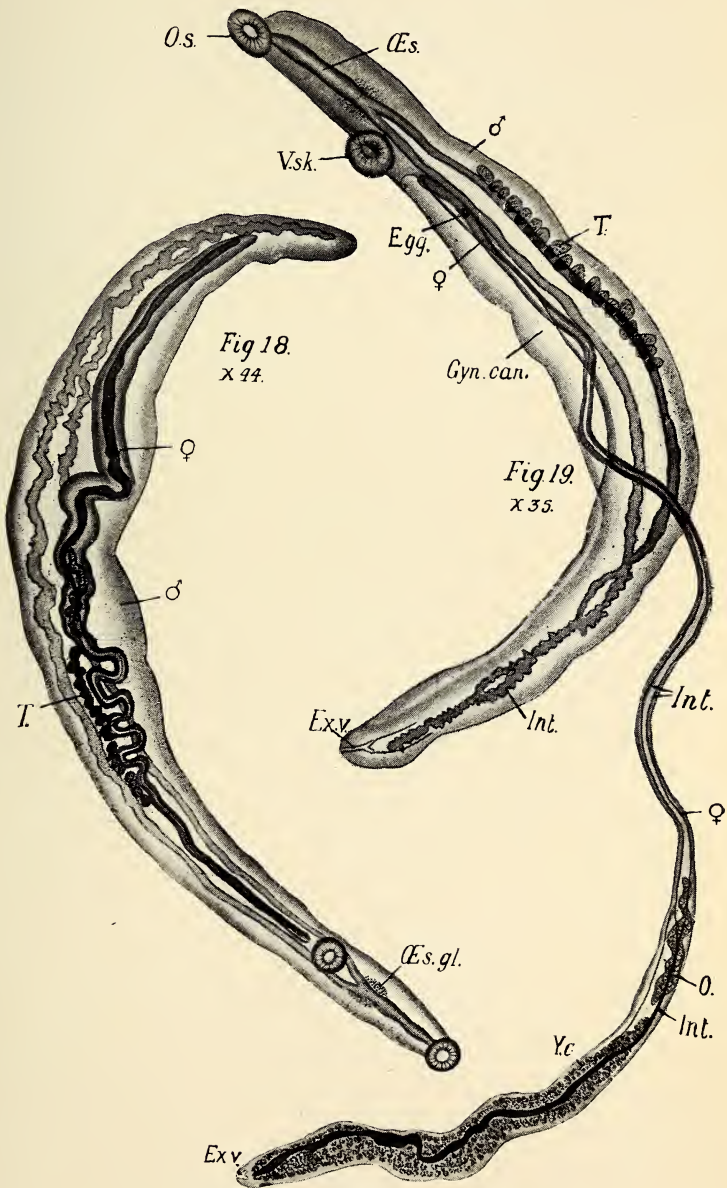




*Harmostomum pulchellum.*



Ex.v.  
*Clinostomum australiense.*



*Austroilharzia terrigalensis.*



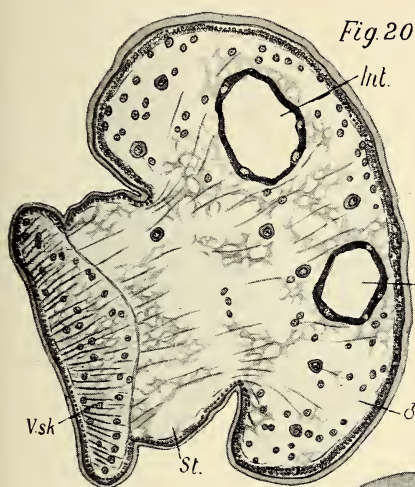


Fig. 20

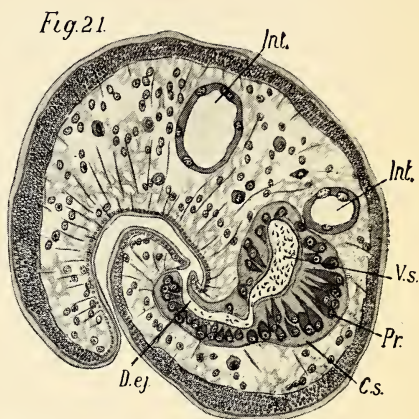


Fig. 21

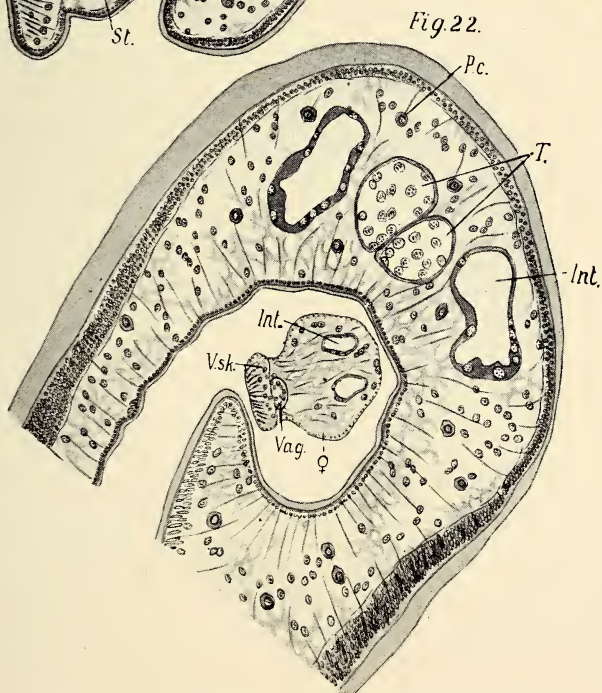
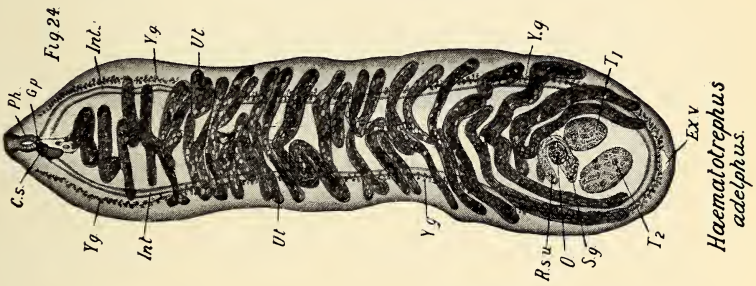
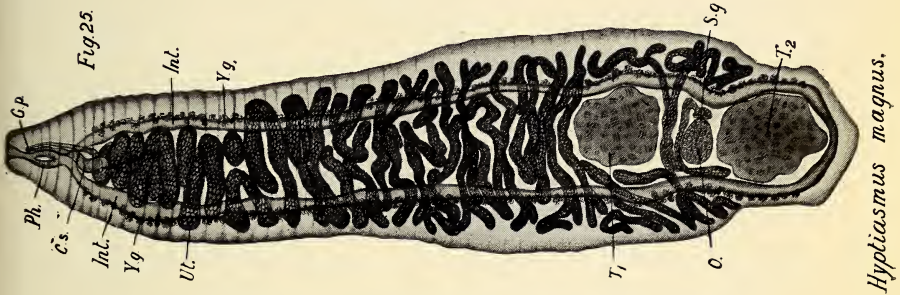


Fig. 22.

*Austroilharzia terrigalensis.*





## PLATE XVI.

Fig. 16.—*Harmostomum pulchellum*, whole mount.  $\times 45$ .

Fig. 17.—*Clinostomum australiense*, whole mount.  $\times 15$ .

## PLATE XVII.

Fig. 18.—*Austrobilharzia terrigalensis*, whole mount with the female lying in the gynecophoral canal of the male.  $\times 44$ .

Fig. 19.—The same species. showing the female almost completely freed from the gynecophoral canal of the male.  $\times 35$ .

## PLATE XVIII.

Fig. 20.—*Austrobilharzia terrigalensis*, transverse section through the male in the region of the ventral sucker. St., stalk of the sucker.  $\times 205$ .

Fig. 21.—T.S. through the cirrus sac and male opening.  $\times 222$ .

Fig. 22.—T.S. through a pair at the level of the ventral sucker of the female.  $\times 240$ .

## PLATE XIX.

Fig. 23.—*Cyclocœlum taxorchis*, whole mount.  $\times 10$ .

Fig. 24.—*Hæmatotrepus adelphus*, whole mount.  $\times 10$ .

Fig. 25.—*Hyptiasmus magnus*, whole mount.  $\times 6$ .

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